Final Report

1 May 2014-28 February 2015

Sustainable Intensification of Key Farming Systems in the Sudano-Sahelian Zone of West Africa

Submitted to
IITA

International Crops Research Institute for the Semi-Arid Tropics

This workis being undertaken as part of the

RESEARCH PROGRAM ON Dryland Systems

Africa RISING Progress Report Template

Instruction: *This template should be used for interim and final technical reports. Final reports should include supporting data (tables and graphs) under Section D. No tables and graphs are needed for interim reports.*

Reporting Period: 1 May 2014-28 February 2015

Section A. Partner Information

A.1. Institute: International Crops Research Institute for the Semi-Arid Tropics (ICRISAT)

A.2. Contact person: Dr Birhanu Zemadim

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A.3. Intervention site, country: Koutiala district area and Bougouni/Yanfolila districts area, Mali

A.4. Partners

Asian Vegetable Research and Development Centre (AVRDC)
International Livestock Research Institute (ILRI)
International Centre for Agro-Forestry (ICRAF)
AfriqueVerte (AMASSA)
Wageningen University and Research Centre (WUR)
Association Malienne d'Eveil et de Developpement Durable (AMEDD)
Cooperatives of the Mouvement Biologique du Mali (MOBIOM)
L'ong-Centre d'Appui a l' Autopromotion pour le Development-ci-apresaenommee (L'ong-CAAD)
Le Groupe de Recherches d'Actions et d'Assistance pour le Development Communautaire (L'ONG-GRAADECOM)

Section B. Summary of progress/achievements during the reporting period (what are the two key achievements?**).**

(i) Integrated watershed management was introduced in the project intervention villages to help integrate multi-disciplinary and multi-institutional activities. Baseline characterization of the local stakeholders was conducted to promote the uptake of sustainable intensification of cereal-based farming system innovations. Thus key players identified at the community level were farmers' organization (FOs). The roles, needs, functions and capacities of the 57 FOs (29 in Koutiala

and 28 in Bougouni) were studied. While the common visions shared by the local FOs include making the agriculture together and contributing to the development of each village, these FOs can be capacitated further to increase impacts of research for development. Institutional mapping of stakeholders' characteristics and interactions revealed that the local NGOs AMEDD and Helvetas are the main identified bridgers/brokers [1] in Koutiala and Bougouni respectively. Similarly ICRISAT and Helvetas were identified as the main hubs[2] in Koutiala and Bougouni respectively. Further our study identified that gender difference was obviously seen in term of access to land, crop seed selection and access to household resources. Men FOs had a better access to seed, fertilizers and equipment than women and youth organizations.

(ii) Ground water was identified as the main source of water supply (77%) for domestic, livestock and irrigation purposes in the studied villages. Inventory of 485 shallow wells (150 in Bougouni and 335 in Koutiala) revealed that construction of shallow wells started in 1904 (in Koutiala) and 1950 (in Bougouni) and since then the number of shallow wells constructed increased exponentially. Shallow well depth range from 2.5m (Bougouni) to 150m (Koutiala). However majority of wells (80%) have a depth range from 6.5 to 10.5m. In addition dry season water level analysis revealed that in majority of wells (77%) water is available in the depth range between 5.5 to 15.5m. Similarly rainy season water level analysis revealed that in majority of wells (75%) water is available with a close range of 0 to 5.5m. The two sites with fast recharging capacity are Sibirila in Bougouni and N'goloniansso in Koutiala. Sirakele in Koutiala is a slow or non-recharging well. This shows that the real problem of water shortage in the studied villages is attributed to water access. This calls for the introduction of new innovation systems to help improve water access from the shallow wells.

Our study further revealed that management of existing natural resources is governed by local conventions in all communities studied. The conventions were reported to be instrumental to (i) better manage natural resources, (ii) reduce conflict, (iii) create opportunities for generation of revenues, (iv) empower local population to manage and decide on the use of their resources and (v) bring together the local population (foster unity). However most of these local conventions existed in an informal or oral form and the level of knowledge of community members on local conventions differed from one individual to another; and from one community to another depending on sex, age and ethnic group.

[1] Bridgers provide valuable opportunities for innovation, growth, and impact because they have access to perspectives, ideas, and networks that are otherwise unknown to most network members.

[2] Hubs are stakeholders in a network with the most influence.

Section C. Implemented work and achievements per output

C.1 Research Output 1 (RO1): Situation Analysis and Program-wide Synthesis. Work-Package WP-1

Title: Socio-economic studies on sustainable intensification in the West African Guinea and Sudan Savanna

C.1.1. Activity 1: Baseline characterization of the local stakeholders to promote the uptake of sustainable intensification of cereal-based farming system innovations in the Sudano-Sahelian zone of Mali

C.1.1.1 Implemented work:

This characterization study was carried out under the innovation platform work package and aims to:

i. Identify and characterize the existing stakeholders involved in agricultural development
ii. Assess the level of interaction among different stakeholders so that we identify gaps needed to be filled to better establish and strengthen institutional linkages and networks among different actors in the system in order to foster awareness and adoption of improved sustainable intensification technologies as posited by the proponents of research for development (R4D) platforms.

C.1.1.2 Achievements

Four different tools were developed and the questionnaires were directed toward key respondents. The tools focused on the following:

- Stakeholder inventory in Bougouni and Koutiala
- Identification of critical main agricultural issues faced by the selected stakeholders
- Analyzing stakeholders interest and influence on the critical issues
- Mapping stakeholder characteristics and interactions.

In addition to the private institutions targeted, the following governmental institutions were considered: agriculture, health, social development, water and forest units, meteorological department. From these exchanges, a set of information were compiled on rainfall, temperature, population and farming systems.

Stakeholder inventory

The main objective of this was to record all organizations (external and internal) working within the site in the areas of agriculture and development. The external (i.e. non community-based organizations) and internal organization and institutions identified in Koutiala and Bougouni covered the following:

- Farmer groups and organizations
- The national agricultural research and extension services (NARES)
- NGOs and other project implementing organizations, and
- Local policy institutions.

For the external group of institutions, the main field of activities was related to: community mobilization, sensitization on critical issues, capacity building of farmers and development agents on agricultural innovations, natural resource management, public health, policy and regulations, as well as on farm plot demonstrations.

The community-based organizations are generally gathered around activities related to crop production, natural resource management and commercialization of agricultural and agroforestry products.

In both cases, the missing institutions that can play an important role within the IPs are traders, input suppliers, agro-dealers and marketing actors. It will be necessary to identify representatives of those actors while operationalizing the R4D platforms at different levels in Koutiala and Bougouni.

Identified external organizations in both Koutiala and Bougouni are presented in Tables 1 and 3 respectively. Similarly lists of existing farmers organizations are presented in Tables 2 and 4 for Koutiala and Bougouni respectively.

Analyzing stakeholder interest and influence on the critical issues

A problem tree exercise to define the key issues, the causes and effects as perceived by each cluster of stakeholders was undertaken to get different perceptions on which stakeholders are prime movers in the system as well as their relative strength of influence. The summary of information gathered from different stakeholders are presented in the spider diagram (Figure 1 to 4) both in Koutiala and Bougouni.

Four main issues were defined to be very critical for a better development of stakeholder activities. These are:

- Lack of training in team leadership and management of organizations
- Ineffective access to appropriate inputs and credit
- Inefficient marketing of agricultural products, and
- Lack of coordination/interactions among support services.

In order to deal with the first issue related to training on team leadership and management of organization, it is very important to involve all identified stakeholders in the process, this can be done through a capacity building on group dynamics and team leadership with additional focus on management.

This can be facilitated by AMEDD and Centre Commercial des Produits Agricoles du Mali (CCPAM) who seem to have a stronger influential power on the issue. They might play a critical role on the platforms in Koutiala. The situation looks a bit diffèrent in Bougouni where Cooperaitive des Riziculteurs et Maraichers (CORIMA), Bureau d'Appui Conseil aux Initiatives Rurales (BACIR) and Cooperative Semenciere Nationale Dalabani (CSN-Dalabani) have been identified as the most influential stakeholders that can facilitate the process of dealing with such issue. There is an avenue to achieve this through their active participation in the different platforms that are being established in Bougouni district within the framework of Africa RISING project and others.

The accessibility and affordability of appropriate inputs and credit is the second issue faced by many stakeholders while implementing their working plans. To address this issue, there is a need to engage the identified stakeholders in a close and sustainable linkage with input dealers and microfinance institutions. R4D platforms can be better avenues to make this effective both in Koutiala and Bougouni. As such, Centre Commercial des Produits Agricoles du Mali (CCPAM), Association Malienne pour la Securite et la Souverainete Alimentaire (AMASSA) and TAGO seem to be the more influential organizations that can significantly impact the issue. They might be very critical actors by playing the role of Bridgers within the platforms in Koutiala.

AMEDD, Centre Commercial des Produits Agricoles du Mali (CCPAM) and TAGO can bridge the networks in Koutiala by facilitating sustainable interactions between different type of actors involved in agricultural products value chains, while Cooperative Semenciere Nationale Dalabani (CSN-Dalabani) can play the same role in Bougouni.

Finally, the characterization also highlighted the lack of coordination/interactions among support services as being an important issue indicating that there is a need to take some actions to address this. It is clearly appearing that AMEDD in Koutiala and MOBIOM in Bougouni look like hubs i.e organizations in the network with the most influential power to deal with the issue. Consequently, their involvement in the different platforms must be critical.

Network analysis

The main objective of this analysis was to map current interactions of the stakeholders, the types and intensity of these interactions, and to get stakeholders to analyze their innovation capacity.

This involved individuals from the represented organizations answering a set of question posed in a questionnaire. These questions were used to map the existing linkages and analyze the strength of the same using social network analysis theories and to make an assessment of different micro-scenarios that represent different elements of the interactions and innovation capacity such as the strength of partnership, knowledge sharing, and coordination of activities to triangulate information, frequency of interaction, and strength of interaction.

Social network analysis (SNA) is a set of theories, tools, and processes for understanding the relationships and structures of a network. The "nodes" of a network in this study are the stakeholders and the "links" are the relationships between people. The maps in this document were created using NETDRAW. Figures 4 and 5 display the patterns of the connections between nodes in Koutiala and Bougouni. A number of lessons can be drawn from these figures:

- In Koutiala, one can identify the appearance of five clusters[3] featured by: (1) AMEDD (Agence Malienne pour l'Environnement et le Development Durable), (2) AMASSA (Association Malienne pour la Securite et la Souverainete Alimentaire), (3) UCPTC (Union des Cooperatives des Producteurs et Transformateurs de Cereales), (4) CCPAM (Centre Commercial des Produits Agricoles du Mali), and, (5) ULCFBV (Union locale de cooperative de la filiere betail et viande).

- Four clusters in Bougouni featured by: (1) MOBIOM (Mouvement Biologique Malien), (2) BACIR (Bureau d'Appui-Conseils aux Initiatives Rurales), (3) COFPROSOTRANS (Cooperative feminine pour la promotion du soja et la transformation des produits agroalimentaires), and, (4) COOP Balimanya (Cooperative Balimanya).

- Some stakeholders can be considered as "bridgers" or "brokers" i.e. stakeholders in the network who have connections to different clusters. AMEDD seems to play that role in Koutiala while Helvetas does the same in Bougouni. Indeed, bridgers provide

[3] According to Hoppe and Reinelt (2010), a cluster is a tightly knit, highly bonded subgroup. Identifying clusters is one of the most important applications of SNA, because it illuminates important previously unrecognized subgroups. Roughly speaking, a cluster is a local region in a network with relatively high density and relatively few links to other clusters.

valuable opportunities for innovation, growth, and impact because they have access to perspectives, ideas, and networks that are otherwise unknown to most network members. Finding bridgers in a network is typically done with the calculation called betweenness centrality (Scott, 2000). This calculation indicates how often one actor is likely to be an important relay point between other network members.

- The maps also show the existence of hubs defined as stakeholders in a network with the most influence. Hubs of influence in a network are best measured using directed links. Given a network of directed relationships, indegree centrality counts how many relationships point towards an actor: this provides a simple measure of influence (Freeman, 1979). In Koutiala, ICRISAT appears to be the most influential stakeholder and Helvetas in Bougouni as they are highly sought-after by other network members.

- In most cases, the interactions among actors in the two sites seem to be guided by a one-way directed links jeopardizing in practice the connectivity of such networks.

C.1.2. Activity 2: Establishment of innovation platforms in Koutiala and Bougouni

C.1.2.1 Implemented work:

Methodological training workshop on IP

A five day training workshop was organized in Koutiala to strengthen the capacity of the stakeholders on innovation platform approach. Four different type of institutions were represented and the biggest part of the attendants coming from the community-based organizations (15 including 5 women-based organizations). The remaining participants were from local NGOs, private sector and public extension and support services.

Establishment of two innovation platforms in Koutiala and Bougouni

Two innovation platforms were established in Koutiala and Bougouni and the operational plans and principles proposed for discussion and approval.

C.1.2.1 Achievements (progress and/or results):

It was commonly agreed that the district-level platforms will hold the meeting quarterly while the commune-level platforms to be established in April for a direct linkage with technology parks planned to be established in two communes (M'pessoba and Flola) will also be holding a quarterly frequency meetings prior to that of the district-level platform.This will be done in the view of a better linkage of actions at different levels through the commune and cercle-based platforms. Number of local institutions that

received short term training on IP approach as the result of Africa RISING project is presented in Figure 6. Figures 7 and 8 reflect potential actors identified for innovation platforms (IPs) in Koutiala and Bougouni respectively.

C.1.3. Activity 1: Monitor Market prices and characterize value chains in Mali

C.1.3.1: Implemented work:

The study aims at developing a database that help to inform and advice farmers and other relevant stakeholders regarding market prices, cost benefit analysis, and support simulation studies. A market database that can be used for agricultural product analyses and knowledge to inform farmers on the dynamics of the market prices is currently being studied.

The target market centers for the study were Bougouni, Koutiala, Diéba, Sibirila, M'Pessoba and Sirakele. In these markets, data collection focused on all agricultural products and inputs especially; dry cereals (maize, sorghum, millet, rice), tubers (potato, sweet potato, yam), vegetables (tomato, onion, pepper), livestock (cattle, sheep, goats, poultry) and agricultural inputs (fertilizer, herbicides, pesticides).

C.1.3.2: Achievements (progress and/or results):

Information collected from the studied villages revealed that there is lack of market awareness, resulting in loss of opportunities for storage and processing of agricultural products. Most notable observation in the villages was farmers experienced immediate sale of agricultural products after harvest, when prices are lowest and competition to sale farm produces was highest. There is lack of reliable information on prices of agricultural inputs and products and farmers tend to sale their produce at cheaper prices.

Example of tomato sale in the village and urban markets is shown in Figure 9 for Bougouni and Koutiala districts. Accordingly tomato prices are lower in the village than urban market centers, and there is a consistent increase of prices from September to December (Figure 9).

Figure 10 depicts price sale of Sorghum in the market centers of Bougouni and Koutiala, representing village and urban markets. Similar to tomato sale, market prices in village markets are lower than urban markets and the prices are falling as more harvest is readily available from November and December harvesting seasons. However we observed a relatively stable market price for sorghum in the village and urban market centers of Koutiala than Bougouni (Figure 10).

C.1.4. Activity 1: Estimating efficiency of farm system components and whole farms (economic and agronomic)

C.1.4.1: Implemented work: Define and propose a framework for data sharing between Africa RISING partners and Wageningen University:

Because IFPRI has developed a data-sharing protocol for Africa RISING project-wide, WUR is no longer developing data sharing methods. For those who are interested, the interactive Nuances website (http://www.africanuances.nl/content/nuances-farmsim) shows the modeling framework and the data requirements for the different model components. It is also possible to upload data to an attached repository.

Information is available regarding data requirements and possible analyses for all models developed by the Plant Production Systems Group of Wageningen University at: http://models.pps.wur.nl/models Information regarding the FARMSIM suite of models, including FIELD, a crop-soil model, and LivSIM, a livestock model is found here: http://models.pps.wur.nl/content/farmsim-integrated-crop-–-livestock-model-developed-analyse-african-smallholder-farm-systems The FarmDESIGN model, developed by Jeroen Groot of the Farming Systems Ecology group of Wageningen University, is based around a multi-objective optimization algorithm. It is documented here: https://sites.google.com/site/farmdesignmodel/home

C.1.4.2: Implemented work: Parameterize component and whole farm system models and determine trade-offs:

Trade-off analysis for intercropping with cowpea was performed for Koutiala district.

An *ex-ante* assessment for maize-cowpea intercropping and cowpea grain variety sole cropping was carried out for four farm types. We considered the average number of cattle, crop land size and cereal yields, costs and benefits of the different farm types and the average yields, costs and benefits obtained in the cowpea and maize-cowpea intercropping trials.

Results of the trade-off analysis are summarized below:

i. large farms would be able to feed only half of their herd (45 cattle) in the stable during the hot dry season when intercropping cowpea on 100% of their maize area, while running the risk of not achieving food self-sufficiency, regardless the intercropping pattern
ii. intercropping cowpea (SP) in only 50% of the maize area of medium farms would provide the fodder for feeding the whole herd (5 cattle) in the stable during the dry season with a minor decrease in food self-sufficiency (Figure

11). Based on the results of the feeding trial and earlier findings by Sanogo (2011), this strategy would have positive feedbacks on milk production and reduced calving interval, providing a solution to the constraints voiced by farmers.

For low resource endowed farms, the trade-off analysis indicated a 30% income increase by replacing half of the millet area by the cowpea grain variety, with a minor decrease in the level of food self-sufficiency (Figure 12)

C.2 Research Output 2(RO2): Integrated Systems Improvement

Work-Package WP-5
Title: Improving Farm and Field Productivity and Profitability in Mali

C.2.1 Activity 1: Develop profitable and sustainable options to intensify productivity of cereal legume based crop, and crop and livestock systems.

C.2.1.1 Implemented work:
The groundnut program conducted on-farm participatory variety selection trials and groundnut varieties demonstrations in Koutiala and Sikasso districts. The program implemented activities in collaboration with two local NGOs: CAAD & GRAADECOM. Summary of the on-farm activities implemented is shown in Table 5.

C.2.1.2 Achievements (progress and/or results):

Groundnut seeds were provided and on-farm trials protocol was given to implement trials in four villages of Bougouni (Dieba, Flola, Sibirila and Madina). The program Scientific Officer (MrDekoroDembele) has provided training to farmers and technical staff of partners on the implementation and management of the on-farm trials.

Quantitative data (yield, agronomic, disease, and maturity) and qualitative data (e.g.,farmers' preference criteria) is currently being analyzed.

C.2.2. Activity 2: Determine farmer practices for cereal/legume vegetable based systems, test integrated innovations and assess productivity and profitability.

C.2.2.1 Implemented work:

Planning workshops took place from 4th to 14th June 2014 in each of the 10 Africa RISING test villages in Bougouni/Yanfolila (Diéba, Yorobougoula, Sibirila, Flola and Madina) and Koutiala (M'Pessoba, Zanzoni, Sirakele, Napossela and N'Golonianasso).

Ten farmers (households) per action village (total of 100) were selected to participate in testing and diffusion of the four most popular vegetable crops, okra (O), pepper (P), tomato (T) and Roselle (R). Two series of trials were carried out. The first series was to test associations of maize with either okra, pepper or tomato in configurations of 100% maize (M), 100% vegetable (V), 75% M + 25% V, 50% M + 50% V, 25% M + 75% V, on plot area basis. In the second series, similar configuration was used to evaluate the performance of groundnut (G) associated with roselle (R) associations. Data have been collected on yield and market value of the tested vegetable, cereal and legume crops and continued until December 2014. Elementary rows data were indeed collected, compiled, cleaned and analyzed.

C.2.2.2 Achievements (progress and/or results):

In the end, 75 famers completed this activity, consisting of 35 intercropping trials in Bougouni/Yanfolila (8 G-R, 7 M-T, 7 M=P and 13 M-O) and 40 trials in Koutiala (12 G-R, 10 M-T, 7 M-P and 11 M-O). Maize intercropped with traditional vegetables (okra and roselle) performed better than with exotic vegetables (tomato and pepper) in terms of vegetative growth and plant vigor. The highest yields were obtained in sole crops of maize, roselle, tomato and pepper. The okra had the highest market value per ha (1 035 602) F CFA followed by roselle (540 214) F CFA and tomato (532 440) F CFA. The maize in pure culture gave good yields but the market values were the lowest. Among the different intercropping systems, 50% M+ 50% Vegetables or 25% M + 75% Vegetables were the best with dominance of 25% M + 75% Vegetables probably due to the high price of vegetable product in rainy season. These preliminary results suggest that intercropping maize with vegetables can contribute to greater food security and generate additional income to satisfy the other needs of the farmers.

C.2.3. Activity 3: Test and disseminate promising technologies to intensify vegetable mono-cropping in cereal-based crop systems in the rainy season

C.2.3.1. Implemented work:
Vegetable mono cropping trials were initiated and carried out in the same zones and at the same period. The trials were carried out by sub-sets of 10 farmers (households) per village in each of the action villages in Bougouni and Koutiala districts (total of 100), using the four most popular vegetable crops (okra, pepper, tomato and roselle) at two planting densities (farmers practice (P) vs. recommended practice (A)). Data were collected on yield and market value and analyzed.

C.2.3.2 Achievements (progress and/or results):
In the end, 81 farmers were able to carry out the trials, with 43 in Bougouni/Yanfolila (18 on okra, 15 on roselle, 5 on tomato and 5 on pepper) against 38 in Koutiala (13 on okra, 15 on roselle and 10 on tomato).

Bougouni/Yanfolila districts:
The results obtained on okra showed that AVRDC okra varieties were more productive than the local check with respectively 892 kg/ha for Konni, 810 kg /ha for Batoumabé against 508 kg/ha for the control. The results also showed significant difference between farmers' practices (809 kg/ha) and AVRDC practice (665 kg/ha). Statistical analysis revealed that the combination of an AVRDC okra variety "Konni" with farmers'practices gave the best results followed by Batoumabé*farmer's practice with 995 kg/ha and 903 kg/ha.

For the roselle variety, the local variety outperformed the two improved varieties giving respectively 152 kg/ha of calyx against 135 kg/ha and 72 kg/ha. The farmer's practice was better than the one recommended (153 kg/ha against 86 kg/ha). The two best combinations varieties*practices were Local variety * farmer's practice and Samandha*farmer's practice with respectively 184 kg/ha and 166 kg/ha. Unexpectedly, AVRDC improved variety L28 with recommended practice gave the lowest yield estimated at 35 kg/ha.

For tomato, yields were highest with two improved varieties (1943 kg/ha and 1860 kg/ha) against 816 kg/ha for the control. There was no significant difference between the two practices (AVRDC recommended practice and farmer's practice). However, it was noted that the combination ICRIXINA*recommended practice gave the highest yield (1946 kg/ha) but not significantly different from the 3 combinations: ICRIXINA*farmer's practice, AVTO112*recommended practice and AVTO1122*farmer's practice with respectively 1940 kg/ha, 1920 kg/ha and 1800 kg/ha. The local hot pepper variety has not been harvested because of its long cycle and couldn't be taken into account in the analysis process.

Koutiala district:
The results on tomato confirmed the superiority of ICRIXINA, AVRDC improved variety with 6185 kg/ha of fruits against 3392 kg/ha for AVTO1122 line and 1972 kg/ha for the control. The two practices tested were significantly different (4096 kg/ha for the recommended practice against 3603 kg/ha for farmer's practice). The combination of ICRIXINA *recommended practice was the best (6355 kg/ha) followed by ICRIXINA*farmer's practice (6015 kg/ha). The lowest yields were obtained with the tomato local variety with respectively 2220 kg/ha for the recommended practice and 1725 kg/ha for the farmer's practice.

The improved okra variety of AVRDC (Batoumabé) was the best with 3837 Kg/ha followed by Konni (2696 Kg/ha and the local okra (2292 Kg/ha), regardless of planting density, though the recommended density gave higher average yield (3025 Kg/ha) than farmer's practice (2858 Kg/ha).

For the roselle, the two AVRDC varieties (Samandah and L28) were the most performing ones with successively 756 Kg/ha, 508 Kg/ha and 441 Kg/ha for the control. AVRDC practice provided better results with 658 Kg/ha against 478 Kg/ha for the farmer's practice. At the interaction level, the Samandah variety with recommended practice gave the best yield in dry calyx almost the double of the other combinations (946 Kg/ha).
No data has been recorded on hot pepper. Thus, this variety has been disregarded from the analysis process.

C.2.4 Activity 4: Develop agro-forestry options for intensive fruit, vegetable and livestock fodder production.

C.2.4.1 Implemented work:

Three sub activities were planned for 2014. They consisted of monitoring fruit tree trials established in 2013 for intensive fruit production from 4 species (*Adansonia digitata, Tamarindus indica, Vitellaria paradoxa and Ziziphus mauritiana*), the establishment of new fruit tree plantation and garden plots for intensive fruit and leafy vegetable production from *Adansonia digitata* (baobab) and *Moringa oleifera* and the implementation of trial for improving soil fertility using fodder and fertilizer tree species. In addition to the these trials, famers in M'pessoba and Koutiala were trained on nursery plant propagation, leadership and group dynamic in order to strengthen their capacity to extent the adoption of agroforestry practices being demonstrated in the framework of Africa RISING project.

C.2.4.2 Achievements (progress and/or results):

Improved fruit tree plantation

Eight accessions grafted on three indigenous fruit tree species (*Adansonia digitata, Tamarindus indidica and Ziziphus mauritiana*) were planted in 2013 in order to determine the effect of irrigation on the growth, the phenology and fruit production on grafted plants.

The accessions were composed of 3 cultivars of *Ziziphus mauritiana* (Gola, 3A, ICRAF08), 3 superior genotypes of *Tamarindus indica* (Niger-309, Thailand sucré,

Thailand Gros fruit), 1 genotype of *Adansonia digitata* (Nonokene) and 1 genotype of *Vitellaria paradoxa* (Samanko-ka).

The trial was established in a randomized block design with 3 replications. M'pessoba, Sirakele and Zanzoni are the villages that had the 3 replications. The experimental unit was composed of 6 plants. The plants were monitored while dead plants were replaced in August 2014. When the root stocks were alive, grafting was done in situ in order to increase their survival rate. The survival rate ranged from 75 to 100 % (Figure 13).

Ziziphus mauritiana was the most sensitive with higher scion and plant mortality compared to *Adansonia digitata* and *Tamarindus indica*. Regarding growth parameter (height, collar diameter, and canopy) the results are summarized in Table 6. There are significant differences among accessions for all the 3 parameters evaluated. Jujub Gola had the highest height while *Vitellaria paradoxa* plants had the lowest height relative growth rate.

Fruit tree species planted in 2014

In 2014, 3 other experiments were established to determine the effect of propagation mode (grafted, non-grafted plants) and irrigation on 2 indigenous fruit tree species *Vitellaria paradoxa* (Samanko-ka) and *Adansonia digitata* (Nonokene), to compare 5 improved cultivars to non-grafted seedlings of *Ziziphus mauritiana* and 3 superior accessions compare to non-grafted *Tamarindus indica*. Grafted and non-grafted plants of *Vitellaria paradoxa* and *Adansonia digitata* were established in a randomized block design with 7 replications (Nampossela, Ngolonianasso, Medina-Kourlamini, Djeba, Flola, Sibirila and Yorobougoula) as other experiments. The experimental unit was composed of 5 plants.

As the factor irrigation has not yet started, propagation mode (grafted, non-grafted), and their interaction along with the villages considered as replications were the factors stated in the statistical analysis. The results of the first evaluation after plantation are given in Tables 7, 8 and 9.

Food banks

Three spacing types (0.3m x 0.3m, 0.5m x 0.5m and 1m x 1m) were used to install 11.25 m^2 plots (4.5m x 2.5m) for leafy vegetable production of *Adansonia digitata* and *Moringa oleifera* in 9 villages out of 10 villages selected for Africa RISING project. Vegetable is being collected every month for selling or consumption.

In collaboration with the local NGO AMEDD two fields of 7 ha in Mpessoba, and 6 ha in Sibirila were managed for water and soil conservation trial. AMEDD technician had laid out four contour lines in each of the fields and also trained farmers for contour line plowing. On the downstream of the contour lines, seedlings of 6 fertilizer and fodder

species (*Acacia angustifolia, Acacia colei, Calliandra callotyrsus, Gliricidia sepium, Moringa oleifera,* and *Piliostigma reticulatum)* were established. The first evaluation revealed high mortality of *M. oleifera, A. angustifolia,* and *C. callotyrsus*. A. colei and P. reticulatum had the highest survival rates.

C.2.5. Activity 5: Analyze and report data from 2013.

C.2.5.1 Implemented work:

Feedback sessions with stakeholders

Feedback sessions were conducted with local stakeholders in all five Africa RISING villages in Bougouni/Yanfolila area. In Koutiala, feedback sessions including economic analysis were carried out in two villages where mechanized micro-dosing trials were conducted in 2013 (Ngolonianasso and Mpessoba). These sessions included discussion of labor requirements for different options as well as economic cost/benefit analysis. Farmers appreciated the low additional labor and capital requirements of the micro-dosing treatments, and noted improved emergence and early plant vigor in treatments where mechanized micro-dosing was practiced.

Plan and implement cereals and legume trials

Five types of trials were planned with farmers in four villages in the district of Bougouni. The five trial types selected were as follows.

- Groundnut variety trial, conducted as a mother-baby design. One mother trial in each village tests fiveimproved varieties plus a local check. The baby trials test twoimproved varieties each.
- Cowpea variety + biopesticide trial: This trial consists of three groundnut varieties: a fodder variety (Dunanfana), a grain variety (IT90K372-1-2 "Wulibali") and a local check. Each variety is planted in two plots, separated by 20m. One plot is sprayed with a neem-based insecticide each sevendays from floral initiation to harvest, the other is not treated.
- Sorghum-cowpea intercropping: Two varieties of cowpea (local and fodder variety Dunanfana) are intercropped with sorghum variety Soumalembainusing two intercropping modes: an additive design, and a substitutive design.
- Maize fertilization: Maize variety Sotubaka, a common OPV, is planted in a two-factor design: Three levels of mineral fertilizer (zero, half the recommended dose, and the full recommended dose) and two levels of organic manure (0 and 6 T/ha) are applied.
- Soya: Variety Houla is planted with two types of fertilization in a two-factor design. One treatment receives inoculum, one receives manure (4T/ha), one receives both manure and inoculum, and a control treatment receives no fertilization.

C.2.5.2 Achievements (progress and/or results):

Results of feedback on 2013 trials showed that common reasons given for better than average yields were: good soil fertility, weeding done on time and additional tillage before or after planting, particularly in soybean. Common reasons provided for poor yields were: damage from animals, poor soils, early end of rainy season and dry spells right after planting and late planting. Data analysis of trials is presented below.

Sorghum: Sorghum yields were very low in most trials. This was due to a combination of factors: some trials were installed on acidic or striga-infested soils. A few trials were installed late due to dry spells in late June and early July, and the season's rains ended early. Bird damage was substantial in some trials. The Soumalemba variety of sorghum is very late-maturing so the combination of late planting and early end to the season had a large impact on yields. Results are presented in Table 10.

Groundnut: Farmers in general appreciated the improved groundnut varieties, and yields were generally higher than the local except in the case of ICGV 02271, which had low emergence but high yield per plant. This variety was noted as having well-filled pods and good grain quality. Variety ICGV 86015 was generally the most preferred variety, with good yields and grain quality. Farmers also mentioned that this variety was easy to harvest: even if the plant was partially senesced, the pods came up easily and few remained in the soil. In contrast, ICIAR 19BT was not well-liked, farmers said it was "lighter" and produced smaller seeds. While it produced a lot of leafy biomass earlier in the season, most of the leaves had fallen before it was harvested. Pod yield results for the different varieties are presented in Figure 14.

Cowpea and organic pest control: The effect of using neem insecticide was not significant at $p<0.05$ however, in the Wulibali variety it was significant at $p<0.1$. Farmers appreciated the wulibali variety for its grain quality and early maturation. Thirteen farmers grew this variety of cowpea in larger areas and most reported good yields, though usually with at least one application of a chemical insecticide—generally the same insecticides that were used on cotton. In Sibirila, the local cowpea variety yielded very little grain in any of the trials. In general, some trials had problems with rainfall: either too much rain at flowering or too little at the end of the season. All trials showed insect damage. Grain yield and halum yield results are presented in Figure 15 and 16 respectively.

Maize: Use of mineral fertilizer had a significant effect on maize grain yield, while the effect of compost was not significant overall. Neither effect was significant in maize stover yield. This trial was initially conceived, with farmers, to investigate lower-cost options for producing maize by limiting the amount of fertilizer applied and using compost, something which few farmers in the Africa RISING villages do. Results are presented in Figure 17.

In order to investigate the economic implications of the trial results we conducted a participatory budget analysis as part of our feedback sessions on the trials. This was something the external reviewers recommended, so we incorporated some of their suggestions into the feedback sessions.

Budget Analysis: Results of the budget analysis differed by village, because costs and prices were different in each location. Examples are presented below.

In Sibirila and Madina, gross margins for maize were negative for most of the treatments, while in Flola and Dieba they tended to be small but positive. Perhaps more interesting than the specifics of the calculation were the discussion that occurred around the results. Most farmers obtain inputs for maize on credit with the CMDT so they often do not know the real cost of the products they use. When conducting the analysis in Flola we found that it was more profitable to apply half the recommended dose of fertilizer even though the resulting yields were lower. One of the participating farmers pointed this out and said that if he had been the one who harvested more, he might brag to his neighbor who harvested less—but it could be that his neighbor was actually better off.

In Madina, several farmers who participated in the meeting were also producers of sorghum seed. These farmers pointed out that based on the results of this analysis sorghum production is more attractive than maize, because while sorghum yields are lower, it does not require as much, if any, fertilizer to produce acceptable yields. One farmer noted that he had produced tree tons of millet on 3 hectares, where his only inputs had been some manure and one liter of herbicide concentrate. Farmers in Madina were interested in having a report on these analyses made available, and on repeating the exercise with other people in the community.

In Sibirila we looked at the effect different yield levels had on the profitability of maize production: one farmer produced the equivalent of 5 tons of maize in some trial treatments. His field was on very fertile soil, had only been cultivated since 2010, and was planted to cotton last year—resulting in near-ideal production conditions. In this case maize production is obviously extremely profitable in comparison to average or below-average yields, but not all farmers have access to such fields. Farmers pointed out that they're aware that maize production is often not profitable, but they grow maize more to

satisfy their own families' food needs than for sale. Given that perspective, we calculated the cost of maize production on a per-sack basis: the effective price to themselves of the maize farmers produce. In some cases this price, even before considering issues like labor, was higher than the price they received for their maize. This was surprising to most of the people participating, but they felt like they had limited other options. This led to a discussion about price policy as well: farmers pointed out that the price for cotton is set, and wondered why the government could not also regulate the price of maize such that it would be profitable for farmers like them.

Both men and women participated in this discussion, though men tended to be more active, in large part because men are larger producers of maize. Women did point out one factor which we did not consider in our analysis, which is the cost of providing food to people who help with field operations. This work is done on an exchange basis and is not paid explicitly, so we did not include it in this very basic initial analysis, but it is worth noting this additional potential cost.

We did not consider labor here, which in the case of the treatments involving organic fertilizers would be significant. Estimates were that spreading manure over one hectare might take up to 3 days with one donkey cart—and many farmers don't have donkey carts, making manure application difficult if not impossible. Yield improvements from applying organic manure would thus need to "pay" for the additional labor required, and given the small observed differences in yield, this may not be a sensible option.

Based on these conversations, as well as discussions held in conjunction with sorghum culinary tests, we are working in collaboration with the FARMSEM project to design trials which will examine whether intensifying sorghum production could be a potentially lower-cost and more economically attractive option for satisfying household food needs. These trials will consist of larger-field tests of improved sorghum varieties with and without fertilizer, and each farmer who participates in the sorghum test will also commit to monitoring one of the maize fields he or she manages. This will allow us to estimate costs and profitability in both crops, as well as relative labor demands, and thus identify conditions in which higher-yielding varieties of sorghum could be attractive intensification options.

C.2.6 Activity 6: Estimating efficiency of farm system components and whole farms (economic and agronomic)

C.2.5.1 Implemented work:
Calibration of the crop/soil model Field-scale Interactions, use Efficiencies and Long-Term soil fertility Development (FIELD) for Malian crop and soil conditions is ongoing. Livestock model LivSim has been calibrated for the Koutiala area, and a paper on this

calibration has been submitted for publication in the journal *Animal* (de Ridder et al.). Required data for modeling and for analysis of farm efficiency, profitability, and trade-offs was collected in the WUR-led farm characterization in 2013, and analysis of the data is in process.

C.2.5.2 Achievements (progress and/or results):
Katrien Descheemaeker from WUR presented on farming system analysis methods and modeling options at a seminar for Africa RISING participants and others in Samanko on 2 September 2014. Mary Ollenburger presented preliminary results of the farm characterization from Bougouni at the same seminar.

Work-Package WP-6
Title: Intensifying Livestock and Poultry Production in Mali

C.2.4 Activity 2: Plan and perform trials on integrated intensification options for livestockfeeding in Mali

C.2.4.1 Implemented work:
Sheep feeding trials were conducted in Yorobougoula, Sibrila and Dieba. Ten participants from each village received 120.000 CFA each for the purchase of three rams. In Yorobougoula all participants are women, while in Sibirila and Dieba there are 5 men and 5 women in each village. All animals received recommended vaccination and treatment against internal and external parasites. Participants were divided into two groups, one using groundnut fodder, and the other using cowpea. Three feeding treatments were used. All animals had free access to water, salt block, and pasture grasses. Beyond these basic rations, one animal received 600g/day of legume fodder only, one received 600g/day of legume fodder plus 400g of maize bran. The third animal receives 900g of legume fodder. Animal weights were measured each 14 days during the two months of the activity.

Following the activity, initial feedback sessions were held where participants noted having problems finding buyers for their animals and requested that the period for repaying the loans be extended until the feast of Tabaski when prices for sheep are high. Since we do not plan to conduct additional rainy-season feeding activities this was accepted and loans will be repaid after 15 October.

Additional feedback sessions will be planned at the time of loan repayment, at which point data analysis will have been finalized and results can be communicated.

C.2.4.2 Achievements (progress and/or results):

Data on animal weights collected every 14 days over the 60-day trial period were entered, as was information on purchase prices and locations. Data on sale prices will be collected as animals are sold, and data analysis is in process.

Work-Package WP-9
Title: Managing Natural Resources to Increase Watershed Productivity in Southern Mali

C.2.5 Activity 1: Village level biomass and pasture assessment and mapping of grazing itineraries

C.2.5.1 Implemented work:
Biomass sampling was conducted in 12 sampling boxes in Sibirila and 12in Dieba in March, May, and July 2014. Five quadrats in each box were sampled for herbaceous biomass. This included measurements of fresh and dry weight and species identification to assist in assessing pasture feed quality. Soil characteristics in each quadrat were also recorded and photos taken prior to cutting. Samples have been processed at ICRISAT-Samanko for dry weight determination. Species identification based on local names, photos, and species sampling is in process in coordination with CGIAR Research Program on Dryland Systems, and this has delayed reporting on this activity.

Collection of tree metrics for all trees and shrubs in sampling boxes was conducted in March 2014. For trees, this included diameter at breast height, tree height, crown height and two crown diameters, as well as observations on foliage density, ground cover under the tree, and tree health. Shrub metrics were more basic as the number of shrubs within the boxes was too large to permit detailed measurements to be taken. Measurements included basal diameter, height, and maximum crown diameter. Peak biomass sampling will be conducted in these boxes in September 2014.

C.2.5.2 Achievements (progress and/or results):

Herbaceous biomass quantity has been measured for 24 sampling boxes in two villages at five bimonthly time periods. Tree metrics were collected for all trees and shrubs within the same 24 sampling boxes.

C.2.6 Activity 1: Documentation and validation of existing local conventions

C.2.6.1 Implemented work:

Analysis of data collected in six communities (Sirakele, Nampossela and Zanzoni in Koutiala district; Dieba, Sibirila and Yorobougoula in Bougouni/Yanfolila district) and drafting of report. In the group discussions, a total of 27 people from local administrations and state technical services in the two districts were involved. In addition, 53 people from traditional institutions in the six communities were engaged in group discussions to analyse the strength and weakness of the existing local conventions in their

communities. Besides group discussions, 165 farmers were interviewed in the six communities including 53 women on their participation in the elaboration, implementation, monitoring and evaluation of local conventions.

C.2.6.2 Achievements (progress and/or results):

i. Comprehensive report on the strength and weakness of the existing local conventions in six communities in Koutiala and Bougouni/Yanfolila districts.
ii. Draft manuscript on "Community Participation in Decentralized Management of Natural Resources in the Sudano-Sahelian Zone of West Africa" was prepared for submission to World Development journal. The draft manuscript is presently under internal review.
iii. Results showed that participation by the community members in elaboration and implementation processes of local conventions was very low in the project communities and tended to be dominated by a group of individuals, often community leaders and elites. The results also suggested that women are marginalized in the processes. Most existing local conventions governing access, use and management of natural resources are oral and informal. Some results from the study are included in Section D of this report (Table 12 to 16; Figure 18 & 19).

C.2.6.3 Implemented work:

Validation workshop of results from the study on local conventions was held in Bougouni and Koutiala between 16 and 18 September 2014. The workshop was held to present the results of the study to the communities for validation. In addition, the implications of the results were discussed and the intervention options to strengthen the elaboration and implementation processes of local conventions in the project communities. The key results were first presented to the participants who then criticized the results if incorrect or validate if consistent with their experience. Fifty eight participants attended the workshop including 11 women. The participants agreed with most of the findings from the study.

C.2.6.4 Achievements (progress and/or results):

i. The workshop provided occasion to provide feedback to the six Africa RISING communities (Dieba, Sibirila, and Yorobougoula in Bougouni district; Nampossséla, Sirakelé and Zanzoni in Koutiala district) where the study on local conventions was conducted.
ii. Identification of socio-institutional options for the application of the results of the study to strengthen the elaboration and implementation processes of local conventions in the communities.

C.2.7 Activity 2: Workshops on conflict management

C.2.7.1 Implemented work:

A training workshop on conflict management over natural resource use in the Sudano-Sahelian Zone of Mali was held between 18 and 22 November, 2014 in Bougouni and Koutiala. A total of 41 participants attended the workshop, including 9 women. Officials from local government authorities and the State technical services were in attendance in addition to opinion leaders from 6 Africa RISING intervention communities. The training addressed methods/tools for participatory conflict analysis, conflict timeline, social relations and communication, and 4Rs analysis (Right, Responsibility, Response, and Relationship) of conflict management. A Malian consultant with expertise in conflict management over natural resource use led the training.

C.2.7.2 Achievements (progress and/or results):

i. Bringing together of the community members, technical services, and officials of the local government authority to discuss the causes of conflict and the innovative approach to resolve the conflict. Sometimes the exchanges were hot between participants from the community members and the officials of the local government who were often perceived by the farmers as partisan in their intervention to resolve conflict. The training provided opportunity to build trust between the community members and the local government officials.
ii. Conflict often arises when different natural resource users focus only on their interest with no consideration for others. This is depicted in the role playing demonstration during the workshop in the Figure in Section D (Figure 20).

C.2.8 Activity 1 Participatory conflict analysis and management

C.2.8.1 Implemented work:
Conduct of surveys to analyze the immediate and long-term causes of conflict over natural resource use and identify options to reduce conflicts and associated problems. Group discussions and individual interviews were carried out in the six study communities addressing inventory of available natural resources, relations among different social groups, causes of conflict over natural resources and the strategies to resolve the conflicts. The group discussions involved key stakeholders in conflict management at the local administrative authorities. In addition, eight Non-Governmental Organizations (NGOs) working on conflict management in the study districts (cercle) were interviewed on their roles and capacity. In each community, 30 individuals including at least 5 women were interviewed on their perceptions on causes and management of conflicts in the community. Those interviewed cut across all the ethnic/social groups in each community.

C.2.8.2 Achievements (progress and/or results):

i. Development of questionnaires for the surveys on participatory conflict analysis
ii. Completion of the data collection in the six study communities, data entry and cleaning. The data collected were not yet analyzed.

C.2.9. Activity: Documentation of transhumance practices

C.2.9.1 Implemented work:

Surveys were carried out to document transhumance practices in the six study communities (Sirakele, Nampossela, Zanzoni in Koutiala district; Dieba, Sibirila and Yorobougoula in Bougouni/Yanfolila district) and the effects of transhumance on natural resource management. In addition, the perception of different social groups in the study communities on the effects of transhumance on gender was also documented. Group discussions were carried out in the six study communities including the traditional leaders and other key informants to document transhumance practices and the effects on natural resources. In addition, 30 individuals were interviewed in each community consisting of 20 farmers and 10 pastoralists (either resident in the community or on transhumance).

C.2.9.2 Achievements (progress and/or results):

(i) Development of questionnaires for the surveys on transhumance practices
(ii) Completion of data collection on transhumance practices in the six study communities, data entry and cleaning.

C.2.10 Activity 4: Establishing and characterization of watershed area for integration of research activities

C.2.10.1 Implemented work: The following activities were conducted within the 10 Africa RISING watershed villages.

i. Survey of existing farmers' organizations within the watershed villages. In Bougouni the identified numbers of farmers' organizations within each watershed village were: Dieba (5), Flola (7), Madina (7), Yorobougoula (4) and Sibirila (6). In total, data was collected from 29 farmers' organizations. In Koutiala the identified farmers' organizations within each watershed village were: Zanzoni (6), Nampossela (6), Ngolonianasso (8), Sirakele (7), M'pessoba (5). In total, data was collected from 32 farmers' organization. The survey data consisted of the following main points among others:
    - Socio-economic and legal profiles of existing farmers' organizations
    - Membership status in the organization that can influence men and women's life
    - Status of food and social security
    - Trends of crop-production along with land and water conservation measures
ii. Survey of existing crop-livestock dynamics within the watershed villages. Random sampling was carried out to get minimum representative samples

from each farmer's organization. In Bougouni watershed villages data was collected from 58 households. Similarly in Koutiala data was collected from 66 households. Survey data consists of the following main points among others:

- System of productivity
- Major issues of crop-livestock systems

iii. Biophysical characteristics of the watershed villages. Here we inventoried and geo-referenced all shallow water wells in Dieba, Flola, Madina and Sibirila. About 30% of wells of Yorobougoula were also inventoried and geo-referenced. In Koutiala district all wells in Nampossela and Sirakele were inventoried and geo-referenced. In other villages the percentage figure was as follows: Zanzoni (50%), Ngolonianasso (70%), M'Pessoba (30%). We also installed 50 ordinary rain gauges (five within each watershed village of Bougouni and Koutiala). To understand the existing soil fertility status of farm fields we collected soil samples from each water village.

iv. In addition to the above activities with funding from the Water, Land and Ecosystems (WLE) and Dryland CRPs we established a watershed area in Koutiala district (Kani watershed). Kani watershed (a drainage area of 57km^2) was selected to integrate multiple activities involving local communities in a participatory approach. The watershed is located at a distance of 450km from Bamako (Mali's capital) in the south eastern direction. Geographically the watershed lies at a latitude of 12.25N and longitude 5.17W with an altitude 379m above sea level. In Kani watershed there are 58 households in scattered locations with scattered farmlands and woodland (parkland). In the watershed we installed five rain gauges and an automatic weather station. Contour bunds were established on four farmer fields. The total area of farm fields with new contour bunds is 4ha. Currently there are four crop trial establishments within the watershed on farm fields with contour bunds and on farm fields without contour bunds.

C.2.10.2 Achievements (progress and/or results):

In the watershed villages of Bougouni/Yanfolila, and Koutiala a participatory method involving meeting with stakeholders, focus groups discussions with leaders of farmers' organizations (FOs) , and on schedule face to face interviews with members of the FOs resulted the following:

1. In Bougouni/Yanfolila there are 28 FOs of which 3 were women groups. 81% of the studied FOs were headed by male presidents against 11 % of women headed farmers organizations. The age of the presidents vary between 34 to 75 years. In Koutiala there are 29 FOs out of which 17% are women associations, 45% are men associations and 38% are mixed associations. Each FO has a president and 79% of the presidents are men and 21% are women. Table 17depicts characteristics of existing FO in Bougouni/Yanfolia watershed villages

2. The common visions shared by local FOs include making the agriculture together and contributing to the development of each village. Membership in local farmers' organization is obtained on the basis of trust, consensus or by vote. The office bearers were selected on the basis of their personal behavior, trust, literacy, their skills and their involvement in village activities.

3. The target villages were known for cotton, maize, millet and vegetable. Cotton is the cash crop and mostly produced by men and mixed associations. The women association focused on rice and groundnut production. This highlights the difference between the gender choice of crops and their ability to have access to seeds and agricultural inputs.

4. Our analyses revealed that gender difference was obviously seen in term of access to land, crop seed selection and access to household resources. Men farmer organizations had a better access to seed, fertilizers and equipment than women and youth organizations.

5. Cotton production represent 50% of the total crops produced and is followed by the production of food crops (Maize, Sorghum, Rice and Millet). Groundnut, sesame and fonio are also grown by local farmers (see Figure 21).

6. Fertilizer was intended for cotton, maize, groundnut and sorghum fields. In the case of cotton an average of 195 kg is applied per hectare, for maize it averages 225 kg/ha, for groundnut 28kg/ha and for sorghum 125 kg per hectare The use of pesticide is exclusively for cotton fields and varies between 1 to 5 litres. Fertilizer use is shown in Table 18 and 19.

7. Crop yield in the studied villages was 0.9 t/ha for cotton and groundnut, 1.6 t/ha for maize, 0.8 t/ha for sorghum and 2.7 t/ha for rice. Looking at the average yield per hectare (Figure 22) we could observe that rice and maize have the highest yield per hectare whereas fonio and cowpea have the lowest yield per hectare.

8. Regarding land and water conservation technics, both traditional and modern technologies were used to reduce land degradation and water erosion. These technologies encompass intercropping, crop rotation, weeding and stone bunding. Contour bunding technology was used in a least measure as soil and water conservation measure resulting from the lack of capacity and awareness of producers on the advantages of the practice.

The biophysical characterization of the studied watershed is explained below:

Climate data: Thirty-one years of daily climate data (1980 to 2010) that includes rainfall, maximum and minimum temperature, solar radiation, wind speed and relative humidity

was collected from Koutiala weather station located in Koutiala district (latitude 12.38N, longitude 5.47W and elevation 367m.
The data was analyzed seasonally and results are presented in Figure 23. Accordingly the computed long term mean daily climatic values are rainfall (2.3mm), maximum temperature (34.3 ^{o}C), and minimum temperature (21.7 ^{o}C), solar radiation (20.2 MJ/m^2), wind speed (2.3m/s) and relative humidity (30.6%). The historical maximum rainfall recorded was 97mm (on 02/08/1998) and the average number of rainy days in a year was 193.

The historical maximum and minimum temperatures recorded were 43 ^{o}C and 8^{o}C respectively. Similarly the historical maximum recorded relative humidity and wind speed were 86% and 5.4m/s respectively. Figure 23 illustrates the relative humidity which is a function of rainfall availability varies greatly across the seasons peaking in the months of August and September. Records of maximum temperature begin to drop during the rainy season having similar pattern as that of minimum temperature. Similarly solar radiation tends to decrease slightly during rainy season and the seasonal variability shown for the wind speed in the region was minimum.

Potential evapotranspiration was computed using the Penman equation and seasonal pattern was shown in Figure 24 along with rainfall. The computed mean annual rainfall and potential evaporation respectively were 845mm and 1752mm. This implies that the PET is more than twice the mean annual rainfall, making it difficult to have open surface water storage.

According to the seasonal rainfall pattern rainfall starts in May, peaks in August and ends in October. Potential evaporation was higher than rainfall for 9 months of the year (October to June). During the 31 years (1980 to 2010) it was evident that slight increase in rainfall was observed (statistically insignificant) (Figure 24).

Water management: Analysis of water management revealed that shallow wells are the most widely sources of water during dry and rainy seasons for domestic, livestock and irrigate water demands. According to Figure 25 shallow wells account 77% of water sources in the watershed villages of Bougouni/Yanfolila and Koutiala. Based on these information we characterized the shallow wells as follows: year and depth of construction, diameter of the well, depth of water in the well during dry and rainy seasons, use of the well and number of households using the wells.

According to Figure 26 in Bougouni/Yanfolila the first well was constructed in Madina village (in 1954) and Sibirila was the village with the maximum number of constructed wells. In Koutiala the first well was constructed in Zanzoni village (in 1904) and

Nampossela was the village with the maximum number of constructed wells. The construction of wells increased exponentially and peaking during 1990 to 2000 (Figure 26).

The analysis on depth of shallow wells revealed that (Figure 27) the minimum well depth is 2.5m in Yorobougoula and the maximum depth is 34.5m in Sibirila in Bougouni/Yanfolila watershed villages. In these villages majority of wells have a depth range from 6.5m to 10.5m. This means for example in Dieba 45% of wells have a depth range of 8.5-10.5m and 76% of wells in Sibirila have depth range from 6.5 to 10.5m.

In Koutiala watershed villages the minimum recorded depth of well was 2.5meter in Zanzoni village and the maximum recorded depth was in 150m in Namposela village. Majority of wells have depths in the range of 6.5m to 10.5m (Figure 27). The diameter of analyzed wells range from 0.9m to 2m, on average 41% of wells have diameter in the range of 1 to 1.2m.

The depths of water in the shallow well was investigated during dry and rainy seasons. In dry season in the majority of wells water is available from depth range of 5.5 to 13.5m. For example in the villages of Dieba and Sibirila water is accessible at a close depth in the range of 5.5 to 9.5m 70% of the times. In Madina village the majority of wells (55%) experience presence of water at a level ranging from 9.5 to 13.5m (Figure 28). In the rainy season except for Sibirila village in the majority of wells 79% (in Dieba), 50% (in Flola) and 55% (in Madina) water was rising to the depth range of 4 to 8m (Figure 28). The trend in Koutiala watershed villages is the same (see Figure 29).

In conclusion: Our study revealed that the PET is twice more than the mean annual rainfall in the watershed villages (from a long term data in Koutiala). This is the result of the aridity situation in the area and surface water storage systems may not work properly. However water can be stored under the ground through recharging the subsurface moisture zone and make it available for various purposes. As evidenced by this study water is available at an accessible depth in both rainy and dry seasons and the issue of water scarcity reported by the rural communities in the watershed villages is probably associated with access. This would require introduction of appropriate water lifting systems in the area from the shallow wells.

For effective management of watershed development we studied the nature and role of existing farmers organizations. Our study revealed that contribution of FOs to food security and socio-economic development is important and they are actively involving in (i) food distribution to members, (ii) loan and credit in nature (cereals) during common ceremonies (marriage, funerals), (iii) collective work, realization of public infrastructure (school, health centre, mosque). However the existing FO in the watershed villages were characterized with (i) low capacity in terms of business management, (ii) poor

involvement in the management of common resources, (iii) low capacity in term of rainwater harvesting and land and water management, and (iV) lack of investments in land water and water conservation technologies due to lack of knowledge on the benefit of land and water conservation measures.

Thus we considered that existing FOs are useful entry points for the development of watershed systems. Among the many practices that are required the development of efficient and inexpensive soil and water conservation technics and introduction of appropriate water lifting mechanisms need to be introduced to have effective watershed development project in southern Mali. In addition strengthening the capacity of existing FOs as custodians of watershed management is necessary to improve production systems and improve resilience towards climate variability and to conserve the natural resource base.

Work-package WP-10

Title: Improving household nutrition through agricultural and behavioral change communication and value addition in Mali

C.2.12 Activity 1: Review and document nutrition activities in Mali

C.2.12.1 Implemented work:

1. Evaluation and planning meetings with local partners in both target villages: Identify demands from women's groups for specific crops and topics for learning and experimentation

A first set of discussion was held from 19-21 April 2014 focusing with village level trainers, and participants in the respective clusters. The results indicated that especially the recipes for improved children's porridge and new options for sauces with green leafy vegetables were being used regularly by participants. The discussions also revealed that beyond the planned feedback sessions in the individual clusters, the trainers, as well cluster participants conducted second tier feedback and training sessions, with members of their households. This information is very encouraging as it indicates that we are in fact reaching the households of the participants in the training sessions, and not only the individual members.

The formal discussions involving also the health center staff, as well as village representatives were conducted on 29 and 30 May 2014. The discussions confirmed the interest of the stakeholders to continue the development and refinement of the curriculum and organizational options for implementing effective 'nutrition field schools'. In both villages the teams agreed to focus on adapting the curriculum, such that during the rainy season the field school activities will focus on improving productivity of women's priority crops. The nutrition training will primarily be conducted during the dry season.

This ensures that the discussions will focus on issues and recipes that are important for the dry season, when different crops, vegetables and fruits are available. This will ensure that the diversity of recipes used for the training sessions will cover a wide range of situations.

2. Cluster-based Farmer Field Schools on groundnut and cowpea production in both villages, with women who participated in Nutrition Field School activities during 2013.

The farmer field school facilitator, hired by our partner AMASSA, was trained in key elements for FFS activities focusing on groundnut and cowpea production by ICRISAT colleagues. The seeds were distributed, protocols developed. Each FFS session on crop cultivation was accompanied by a set of key nutrition messages, based on last years' topics, and on discussions and questions raised by participants, as listed in the Table 20.

3. Development of short nutrition and health modules for inclusion in field sessions of the FFS meetings. Three leaflets for distribution to the participants in Nutrition Field Schools were produced and distributed by AMEDD: ''Food groups'; 'Vitamin A'; 'Importance of Iron and Iodine and their availability'. Discussion guides were developed to ensure that participants are aware of the advantages of different green leaves as source of food, and as a source of vitamins and minerals. The importance of reduced cooking was included.

4. Distribution of seed of field crops, mostly sorghum hybrids, to individual FFS participants for farmer testing. The participants in the nutrition field schools from 2013 received each 2 packets of 500g of sorghum seed. One packet was for the participant herself, and one for the family head, and thus the family field. In Sirakele a total of 450 packets were distributed and in M'pessoba 400. The hybrids Pablo and Fadda were chosen for the distribution. Feedback from recipients was collected informally.

5. Nutrition Field School sessions during dry season months, adapting recipes to availability of local products. This is presented in Table 22.

6. Culinary evaluation of newly introduced sorghum varieties, involving Nutrition Field School trainers from M'pessoba villages. On 16 February 2015 the feedback discussion on the sorghum variety trials (2x16 entries) conducted with 4 replications in M'pessoba with support from HOPE (BMGF) and FARMSEM (USAID) projects. Farmers chose 3 new varieties, one hybrid in dissemination (Fadda) and a local variety for culinary evaluations. On 17 February 2015 the culinary tests were organized with 3 women groups conducting the tests. One of the women groups was composed of Nutrition Field School trainers from the nearest quartier.

7. Testing of rainy season vegetable crops and varieties was conducted in the same plots as the farmer field school observations on groundnut and cowpea. This is reported separately by AVRDC.

8. Evaluation of use of whole grain sorghum recipes in villages where the Nutrition Field Schools have been implemented by the ICRISAT gender team, as part of the global gender study.

C.2.12.2 Achievements (progress and/or results):

Evaluation of 2013 and Planning for 2014: The discussions at village level as well as with local health centers and the 'Medecin chef' from Koutiala showed strong support and interest in the nutrition field school activities. The women groups in both villages were keen to continue both types of activities – nutrition experiential earning with cooking demonstrations and activities, as well as testing crops that are important to them, legumes and vegetables, in association with cereals.

The health centers are increasingly collaborating with the local women trainers in the villages to assist mothers with malnourished children undergoing treatment in their learning about child nutrition and recipes based on local products that provide complete nutrition and are appropriate for children. The Medecin chef of Koutiala supports the activities for the same reasons. Both partner NGO's were ready to engage in the activities, revise the content as necessary, and learn about new crops and technologies. Both NGO teams have worked well together, with complimentary expertise and experiences, and are ready to continue the collaboration for capacity building of the women's groups in these two villages.

Cluster-based Farmer Field Schools on groundnut and cowpea production in both villages, with women who participated in Nutrition Field Scholl activities during 2013. :

Choice of fields: In both villages and in each quartier of both villages, women who wanted to participate in the FFS had to negotiate access to land for conducting the Farmer Field School site, as well as for Training of Trainers site. As Koutiala is the most densely populated agricultural area in Mali, access to land for individual women, as well as women's groups is specifically difficult. Except for one group, all groups managed this difficult hurdle of negotiation. It was especially difficult in 2014, as there were heavy early rains that tend to favor cereal cultivation, so some of the fields that the women received for the FFS work was of extremely low fertility. While this may create some problems with loss of data, or inhomogeneity in the fields, our experience indicates that farmers, and especially women farmers are easily convinced of the benefit of a new technology, if it proves itself superior under marginal soil or crop management conditions.

Groundnut trials**:** The following groundnut varieties were tested with and without improved crop management practices: ICGV 86124, ICGV86024, ICGV86015, ICGV03056, ICIAR 19BT. Each quartier added their own local variety.

Cowpea trials: At Sirakele the women tested 3 grain type varieties of cowpea, Korobalen, Maradi locale Wilibali, and one forage type variety: Sankaranka. At M'pessoba only the two grain type varieties were tested, Korobalen and Wilibali.

Vegetable Crops: The vegetable plots were established by AVRDC in the same fields as the groundnut and cowpea trials. The same women's groups were involved with the field and learning activities about vegetables as for groundnut and cowpea.

Trial design: For both groundnut and cowpea each FFS site had two large plots – Farmer practice and Improved Practice. The difference was that the Improved Practice received fertilizer at the rate of 2 g per planting hole, or 80kg of DAP per ha. The plant stand density for the Improved Practice was higher than for the Farmer Practice. All the varieties were tested under both Improved and Farmer practice conditions at each FFS site. The plot size was 6 rows of 8m.

The cowpea trials were fully treated with locally prepared Neem extracts to control flower and pod insects, to identify practices that allow the consumption of leaves during the growing period. Data analysis: The data were analyzed, using the REML procedure of Genstat, treating each field and the two practices as sites. The overall analysis of variance is presented in Table 23.

The results show that the overall mean yield was close to the mean yields obtained by farmers in Mali with cowpea. This is actually encouraging, considering that the women had received some of the worst land available in the villages for these trials. These results thus also indicate the commitment of the women to these experiments.

Table 23 shows clearly those differences between the 4 fields were highly significant, differences between the varieties were also highly significant. The difference between the two practices also was significant in Sirakele. The varietal and agronomic performance data are shown in Figure 30. The highest yielding varieties were Wilibali and Maradi Local, while Korobalen was very similar to the local. The grain yield of the forage type cowpea variety was extremely low. The measurements of forage yields did not succeed due to lack of secured drying facilities in the quartiers.

The Anova (Table 23) shows, that despite the low number of fields that could be harvested for grain yield, fields, varieties and the agronomic practice showed significant differences. The mean yield was slightly higher than in Sirakele. The results for the two test varieties are presented in Figure 31, and show the superioty of the variety Wilibali.

Table 24 lists the varietal preferences for each of the women's groups, as expressed during the last FFS session in each village. The preferences are clearly for the grain types in Sirakele village, but not always for the variety with the highest grain yields recorded. The grain yield weights may have certain errors, due to the fact that some harvest of pod occurred before the session at which weighing occurred. Thus the preference results may be more indicative of superiority. They are certainly clear indications of preferences for these women. The benefit of the improved practice for cowpeas does not seem economically viable at this yield level. Farmers evaluated the Neem treatment as insufficient overall, and mentioned concerns about it contributing to leaf burning, and flower drop. As the plots were too small for spray treatment comparisons the benefits and problems associated with the Neem treatment cannot be fully assessed.

Groundnut variety trials: The fresh groundnut yields at the two sites were generally low due to low soil fertility at the testing sites. At M'pessoba one variety did not germinate, so could not be included in the comparison.

As yield observations did not show significant differences, the evaluation of preferences for specific varieties and the criteria elicited for the varietal choice are an important result of this evaluation. It seems that the variety ICGV 86124 is preferred by a large number of women farmers, followed by ICGV 86015. The criteria noted most often were actually related to good and vigorous growth and flowering, followed by large grain size.

Varietal choice by the different women groups in Sirakele village at flowering and at harvest is presented in Table 25

Distribution of sorghum seed to women and to family heads: During informal evaluations by the breeding team and independently the gender team, women mentioned the benefits of the new varieties in terms of productivity and appropriate flowering. Some women mentioned good processing characteristics.

Culinary evaluations of new sorghum varieties: As culinary tests are still continuing, results have not yet been analyzed. The culinary test in M'pessoba village was a good opportunity to hold informal discussions with women who participated in the Nutrition field schools.

These discussions hinted at wide range of gender impacts of the nutrition field schools, besides knowledge about nutrition. Women indicated regular use of key elements of new recipes: use of whole grain sorghum, shorter cooking periods, green leafy vegetables, using vegetables destined for sale also for their own food, adding cowpea or groundnut or soyflour to children's porridge. Several women did describe the beneficial effects of the improved porridge recipes, the hygiene practices and general child feeding practices on

the health, growth and development of their children. In addition women mentioned the benefits of becoming more self-confident from speaking on front of others. Even asking the husband for a piece of land, and thus cultivating groundnuts and other crops by herself were mentioned as an outcome.

Evaluations conducted by the gender team in the Nutrition Field School villages: In the context of the global study on technology and gender norms conducted by the Gender research network of the Consortium office of the CGIAR the gender team did conduct focus groups discussions in Sirakele and one quartier of M'Pessoba, Lassanabougou. While discussing technology changes in the villages, production technologies from Africa RISING experimentation were mentioned, such as new sorghum, cowpea, groundnut and gombo varieties. In both focus groups the use of whole sorghum grain cooking healthier meals for children were also mentioned as being used regularly. As well the general benefits of targeting technology introduction and adaptation to the needs of women in rural areas.

The following can be concluded from the result of the study:

i. The Nutrition Field School Concept and experiences with its implementation are generating widespread interest in the research for development community from both the nutrition and health sector as well the agricultural sector. It is thus crucial that the team, newly re-energized through the leadership of AVRDC strives to document key elements of the specific training modules used, approaches used for integrating training for crop production knowledge with nutrition and food preparation knowledge.
ii. In addition it will be important to conduct evaluations with the participants of specific aspects of outcomes, as mentioned above. This will help to draw lessons for further improvement as well as for dissemination. In addition to food security and crop and food diversity, it will be important to explore issues related to women's capacity building.
iii. To allow for these evaluations and further development it is important that the team of trainers, facilitators and implementers from the NGO's AMEDD and AMASSA can continue to work together in this context to support the development of these women groups, and their capacity to produce and prepare health and complete meals for their children.

Research Output 3 (RO3): Scaling and Delivery. Please refer to the Program Document for Activity Headings.

A video on various aspects of land and water management was shown to representative farmers in Koutiala district. Similarly, various varieties of sorghum and groundnut seeds were distributed to Bougouni and Koutiala farmers. ARDT_SMS program is working on large scale diffusion of technologies for Sorghum and Millet systems in Sikasso region. It's described below.

C.3.3. Additional activities, if any:

Africa RISING's Large-Scale Diffusion of Technologies for Sorghum and Millet Systems in Mali (ARDT_SMS)

Here implemented activities and achievements for the Africa RISING's large-scale Diffusion of Technologies for Sorghum and Millet Systems - ARDT-SMS project in Mali are reported. Establishment of **Farmer Fields Schools** in Mopti and Sikasso, several market plots for the **demonstration of sorghum hybrid's seed** production and its **culinary tests' results**. The Promotion of **farmers' study tours** and **media related activities** are reported as well.

All TOT plots for Farmers' field's schools have been harvested and threshed in the 28 communes (18 communes in Mopti and 10 in Sikasso) of project interventions.
In order to have the level of appreciation of millet and sorghum technologies and varieties by the farmers, from the survey carried out by CRS among leaders producers who participating in the FFS activities, it has been noticed that; the trainers and producers appreciated integrated striga and soil fertility management techniques (ISMSF) most for the highest grain yield (millet and cowpeas), and found that the economic gain more than compensates for the investment and physical effort. The fertilizer rate appreciated by farmers is 1/1 g micro dose applied at the sowing time as it is less costly.

In terms of improved millet varieties, Torognou is favored by producers in all of the targeted districts in the Mopti region, because it is; early maturing, highly productive and has large grains.
In the Sikasso region, 100% of the covered communes preferred the Soumalemba sorghum variety, while in Koutiala, all collaborative communes preferred Pablo and Faada sorghum varieties because of their high yielding and their resistance to drought. For cowpeas producers preferred the Korobalen variety because it has the highest yield and early maturing.
According to the culinary results, Pablo (sorhghum) variety has a strong preference for producers from Sikasso region. The project broadcasted documentary movie on the production and use of sorghum hybrid seed at national media (TV and Radio stations) and produced audio CD with local radio stations in Bougouni (Banimonotié and Kafokan).

Three study tours for exchanging experiences were organized around hybrid seed production, fields of sorghum and demonstrations plots located at Faragouaran, Oure and CAA Samanko. These visits have combined more than 625 producers, and students of which 190 were women.

C.4 Research Output 4 (RO4): Monitoring and Evaluation

No activities implemented by ICRISAT and partners in Mali. However IFPRI conducted a baseline survey and we are waiting for their report

C.4.X. Additional activities, if any:

There are no additional activities

C.5. Research Deliverables

C.5.1. Products

C.5.2 Technology/technologies transferred

- Local farmers were trained on contour bunding technology and have applied in their farm fields.
- Cow pea varieties: Korobalen and Wulibali have entered into the associated seed production program. Seed cooperatives in the AR villages are producing certified seed.
- Sorghum hybrids, Pablo, Fadda and Sewa, as well as varieties Tieble, Jakumbe and Boboje are being produced on a large scale by cooperatives in the AR villages. Seed sales in the Koutiala region are presently being totaled.

C.5.3 Meetings/presentations

- Mali Africa RISNG workshop was conducted from 26 to 27 February 2015 in Sikasso, Southern Mali. The two days meeting was mainly to evaluate progress and presentation of results of the 2013/2014 activities. It is interesting to see that all partners presented their findings. Some useful discussions were conducted and the way forward was outlined. Main finding during the two days discussion is outlined below. Detailed report is available in French and English.
    - Generally all participants were satisfied to see an integrated approach (multi-disciplinary and multi-institutional approach to address the sustainable intensification options in Southern Mali) and all partners were actively engaged during the science deliberations.
    - There are good opportunities to intensify livestock activities, for example with the use of cowpea for grain and fodder production in Bougouni.
    - There is a possibility to re-invigorate dry season farming practices
    - Local conventions would help the NRM once formalized and are an important input for integrated watershed management.
    - Bringing farmers to our science meeting was an added value.
        - Adama Berthe, an invited farmer to the workshop gave his reflection on the activities in his field.

        - Other participating farmers were glad to hear our data analysis results
        - Farmers promised to inform their fellows in their village regarding the meeting and what they heard in their own local language
        - Integration of farmers with researchers would increase the benefit of the research finding-uptake strategy
        - Understand the benefit of the research for smallholder farmers
        - Project is showing more technologies and farmers are willing to adopt
    - Inclusion of new local partners GRADCOM and CAAD was helpful to have proper intensification options-groundnut productivity
        - Engagement in other Africa RISING villages by these institutes is required for 2015 and beyond
    - Bringing the idea of Technology Parks (TP) would help more integration: Water access is an issue to be discussed among ICRISAT, ICRAF and AVRDC for the currently established TPs
    - Analyzed data will be reported to the annual report, due 15th March 2015
    - Lack of proper follow-up of few experimental set-ups in Koutiala was an issue
    - Participants witnessed that not all villages were covered by the study and there is a need to consider other villages as well.
- Mid-term external evaluation of the Africa RISING project in October 2014.
- A joint Ghana-Mali household nutrition planning workshop was organized in Ouagadougou-Burkina Faso on the 14th and 15th January 2015. This meeting allowed identifying common goal for Mali and Ghana and drafting the work plan for 2015.

C.5.4 Reports/publications

The following reports are available:

- Mali Africa RISNG workshop program workshop from 26 to 27 February 2015 in Sikasso, Southern Mali.
- Women groups training mission on groundnut improvement in Sikasso and Koutiala areas
- Formation « Aménagementsencourbes de niveaudans les zones tropicales semi arides » – 16 et 17 Juin 2014. Report available in English and French
- Progress of Africa RISING supported groundnut activities
- Biophysical data collection from AFRICA RISING intervention sites in Bougouni and Koutiala districts
- Trip report on reception of garden fence and large diameter wells. This report presents Africa RISING sponsored construction of garden fence and large diameter wells in Yorobougoula. The garden fence was constructed to integrate activities of ICRISAT, ICRAF and AVRDC during off-season crop and vegetable production

- Analysis on strength and weakness of the existing local conventions in Koutiala and Bougouni districts
- Manuscript on evaluation of feed resources in Southern Mali submitted to Tropical Animal Health and Production
- Abstract on evaluation of feed resources in Southern Mali submitted to International Conference on Integrated systems, Ibadan, Nigeria accepted for poster presentation
- Manuscript submitted on "Milk, the new white gold for smallholder farmers in West Africa?" Submitted to *Animal Journal*
- Chronogram of ILRI-led activities for the period September 2014 to June 2015
- Characterization of farming systems in Africa RISING intervention sites in Malawi, Tanzania, Ghana and Mali. March report submitted to IITA by Department of Plant Sciences,Wageningen University and Research Centre
- Draft manuscript on participation in decentralized natural resource management in Sudano-Sahelian zone of Mali for submission to World Development journal

C.5.5. Capacity building (Type of training, number and category of people trained)

- Two ICRISAT research assistants (Cedrick Gedessou and Marc Traore) were trained in Tamale, Ghana on project management skills. The training was organized by IFPRI for one day (1 August 2014).
- Two ICRISAT research assistants (Cedrick Gedessou and SinareBoubacar) were trained in Accra, Ghana on the use of statistical software (SAS). The training was organized by IITA for five days (4-8 August 2014).
- Fifty nine farmers from Koutiala district were trained on better land and water management practices. The two days training (16 &17June 2014) focused on video demonstration of improved land and water management practices and participating in actual construction of contour bunds in farm fields. The local NGO AMEDD facilitated farmers training. Report available in English and French.
- Women were trained for seven days in Koutiala and Sikasso areas. From 26 June2014 to 2 July 2014, ICRISAT and the local NGOs (GRAADECOM and CAAD) offered the training for 135 women on the recommended techniques of groundnut improvement (report is available). The objective of the training was to reinforce farmer's knowledge on the recommended techniques of how to grow groundnut (from the choice of the type of the soil to the harvest time and the post-harvest management) and to dispatch the seeds so that production and the productivity of groundnut is improved. Specifically the following were the main areas of training:
    - How to grow groundnut
    - Understanding types and issues of improved groundnut varieties
    - Right period of groundnut planting
    - Different diseases of groundnut and how to fight them
    - Post-harvest management
    - How to use fertilizer

- Training in conflict management over natural resource use was held in Bougouni and Koutiala in November 2014. A total of 41 participants attended the workshop, including 9 women. Officials from local government and the State technical services were in attendance in addition to opinion leaders from 6 Africa RISING intervention communities. The training addressed methods/tools for participatory conflict analysis, conflict timeline, social relations and communication, and 4Rs analysis (Right, Responsibility, Response, and Relationship) of conflict management.

- Training was organized from 18th to 24th August 2014 i) to increase farmers' knowledge on vegetable technical itineraries with focus on nursery techniques, land preparation to avoid flood or to optimize the water needs and plant protection during the rainy season and ii) to inform the farmers about the test management conditions. A total of 177 farmers including 71 male and 106 female were in attendance. In addition, two BSc students and four non-degree interns participated in studies on integrated cropping systems, vegetable postharvest techniques and seed production under the project.

C.6. Problems/challenges and measures taken*(100 words)*

There has not been major challenge so far during the reporting period

C.7. Partnership/linkages with other projects (*100 words****)***

- Synergies have been created with the following programs: Water, Land and Ecosystems (WLE), Dry land System (DS), FARMSEM project, Africa RISING large scale diffusion of Sorghum and Millet,.
- The activities on local conventions and participatory conflict management fit quite well with CRP Dryland Systems activities on strengthening local institutions for sustainable natural resource management

C.8. Lessons learned (*100 words****)***

- Integrated watershed management was introduced in the project intervention villages to help integrate multi-disciplinary and multi-institutional activities. Key players identified for the development of watershed management programs are farmers' organization (FOs). Brief survey was conducted to understand the roles, needs and functions of the 57 FOs in the studied watershed villages. Capacity building and awareness programs are needed to strengthen the FOs and achieve project development goals sustainably. This helps to avoid silos approach. The various activities the project conducts; seed system and varietal selection, agronomic practices that includes crop improvement programs, soil and water conservation practices, tree systems associated to fodder and improved soil fertility practices, and market research could be synchronized systematically to achieve high impact during the project period and beyond.

- Groundnut is an important crop both for home consumption and for sale, and was the highest priority crop requested for trials. Some farmers requested early varieties; others said the time to maturity was unimportant as long as the yield was good.
- Farmers were also interested in trials involving maize, particularly surrounding fertilization options that would require less investment in mineral fertilizers. Manure use is not common, and farmers are interested in testing the benefits of organic manures. They have several improved varieties available to them and are in general satisfied with varietal performance, proper management of fertility is more important in this case.
- Crop intensification options focused in two areas: improving productivity of crops for consumption and market, and testing legume crops for maintaining cropping system diversity and soil fertility. Key crops targeted for productivity improvement are maize and groundnut, while cowpea in both intercrop and pure stand is targeted for diversity and soil fertility benefits. Soybean, as a new crop in the area, has potential benefits as a market crop, beneficial for improved nutrition, and as a legume which drops its leaves before harvest, it provides additional inputs of high-quality residues to the soil.
- In most farmer fields there is a limited use of manure and crop residue recycling. Training (capacity building programs) is required to improve productivity and nutrient cycling.
- Market access is limited thus affecting the incomes of local communities. Improved marketing system can lead to increased farm earnings at household level. This can be worked with local NGOs, private sector and government institutions.
- Land is widely available and is a good opportunity for extensive farming system. However labor limitations around planting seasons are common. Few portions of farm fields are planted less than expected. Similarly extensive livestock production means off-farm pasture is a key resource and overyielding in the intercrop gives opportunities for farmers to feed their livestock better without increasing cultivated land area.
- All local communities have local conventions governing access to, use and management of natural resources but these are mostly in oral form which is partly responsible for weak enforcement of these rules and byelaws. It is therefore necessary to formalize the oral local conventions through proper documentation and approval by the local administrative authorities.
- There is generally low level of participation of most community members in the elaboration processes and implementation of the local conventions in all the study communities. This low level of participation confirms the general perception that decentralization reforms in most West Africa Sahelian countries have been captured and dominated by the elites.
- The common feature of conflict is the presence of multiple nature resource actors (users) who focus on their interest only with little or no consideration for others. Conflict resolution often begins with consultation at community level with village chief and opinion leaders. While most cases of conflict are resolved at community

level, there are conflicts that are resolved through the intervention of local administrative authority and sometimes civil court.

Section D. Tables and graphs in support of achievements, results (for final report only)

Table 1: External organization identified in Koutiala

No.	Name of organization	Type of organization	Type of activities 1	Type of activities 2	Type of activities 3
1	AMASSA	NGO	Community mobilisation	Capacity building farmers on agricultural innovations	On-farm plots demonstration
2	AMEDD	NGO	Community mobilization	Capacity building of farmers on agricultural innovations	Natural resource management
3	Decentralized Agricultural service	Extension department	Community mobilisation	On-farm demonstration of technologies	Capacity building of farmers
4	Health Centre	Health department	Heath		
5	Chamber of Agriculture	Community office	Community mobilisation	Marketing	
6	Decentralized water and forest service	Extension department	Natural resource management	Sensitization	Policy and regulations
7	Social development service	Social service	Community mobilisation	Sensitization	
8	The Local council	Community office	Community mobilisation	Sensitization	Policy

Table 2: Farmers organizations identified in Koutiala

No.	Name of organization	Type of organization	Type of activities 1	Type of activities 2	Type of activities 3
1	Association des veuves 'Allah makono'	Community women-based organization	Crop production		
2	CMRN	Mixed groups	Crop production	Commercialization of agricultural products	
3	Cooperative agricole TAGO	Community men-based organization	Crop production	Commercialization of agricultural products	
4	UCPTC	Mixed group	Crop production	Natural resource management	Commercialization of agricultural products
5	Association des femmes de Sirakele	Community women-based organization	Crop production	Commercialization of agricultural products	
6	ULCGRN	Mixed groups	Crop production	Natural resource management	
7	ULPP	Mixed groups	Crop production	Natural resource management	
8	ULCFBV	Mixed groups	Crop production		
9	ULCMK	Mixed groups	Crop production	Vegetable farming	
10	UFROAT	Community women-based organization	Crop production	Vegetable farming	
11	ULMB	Community men-based organization	Natural resource management	Commercialization of agricultural products	

Table 3: External organization identified in Bougouni

No.	Name of organization	Type of organization	Type of activities 1	Type of activities 2	Type of activities 3
1	AMEDD	NGO	Community mobilization	Capacity building of farmers on agricultural innovations	Natural resource management
2	Coordination des ONG locales	NGO	Community mobilisation		
3	Decentralized Agricultural service	Extension department	Community mobilisation	On-farm demonstration of technologies	Capacity building of farmers
4	Decentralized water and forest service	Extension department	Natural resource management	Sensitization	Policy and regulations
5	Meteorological service	Extension department	Weather	Agricultural information support	
6	Livestock production service	Extension department	Community mobilisation	Dissemination of innovations	Farmer training
7	Chamber of Agriculture	Community office	Community mobilisation	Marketing	
8	Health Centre	Health department	Heath		
9	Social development service	Social service	Community mobilisation	Sensitization	
10	The Local council	Community office	Community mobilisation	Sensitization	Policy

Table 4: Farmers organizations identified in Bougouni

No.	Name of organization	Type of organization	Type of activities 1	Type of activities 2	Type of activities 3
1	MOBIOM	NGO	Crop production	Natural resource management	Commercialization of agricultural products
2	COPROSOTRANS	Women-only groups	Crop production	Commercialization of agricultural products	
3	Cooperative BENKAN	Mixed groups	Natural resource management	Commercialization of agricultural products	
4	CAALUCOP	Women-only groups	Crop production	Commercialization of agricultural products	
5	Cooperative Missiba Nono	Men-only groups	Crop production		
6	Cooperative des jeunes ruraux	Men-only groups	Crop production	Natural resource management	Commercialization of agricultural products
7	Cooperative des agro dealers	Men-only groups	Crop production	Commercialization of agricultural products	
8	Cooperative de Kologo	Mixed groups	Crop production		
9	Cooperative Dunkafa de Mena	Mixed groups	Crop production		
10	Cooperatives des producteurs cerealiers	Men-only groups	Crop production		
11	Cooperatives des riziculteurs et maraichers	Mixed groups	Crop production	Epargne	Commercialization of agricultural products
12	Cooperative Sougouba	Mixed groups	Crop production		

Table 5: Summary of activities implemented for groundnut intensification

N°	Effected activities	Number	Entries	Location	Region	Villages	Partner NGOs
1	PVS trials	20	80	Sikasso	Sikasso	Dougoumousso, Zerelani, Natoumana, Tinzanadougou and Foh	GRAADECOM
		5	28	Koutiala	Sikasso	M'Pèrèsso, Banian, Try I, Finkolo and Sanakorobougou	CAAD
	Subtotal	**25**	**108**				
2	Baby trials	120	240	Sikasso	Sikasso	Dougoumousso, Zerelani, Natoumana, Tinzanadougou and Foh	GRAADECOM
		25	50	Koutiala	Sikasso	M'Pèrèsso, Banian, Try I, Kaniko, N'Goukan, Nampossela	CAAD
	Subtotal	**145**	**290**				
3	Demonstrations	3	12	Koutiala	Sikasso	Kaniko, N'Goukan, Nampossela	CAAD
	Subtotal	**3**	**9**				
	Seed multiplication	1	2	Koutiala	Sikasso	Nizanso and Nampossela	CAAD
4	Training	100		Sikasso	Sikasso		GRAADECOM
		57		Koutiala	Sikasso		CAAD
	Subtotal	**157**					

Table 6. Growth parameters monitored on 8 accessions planted in 2013 in Koutiala and Bougouni cerles in Mali. Mean ± SE followed by the same letter are not significantly different at the 5% level according to Tukey's multiple comparison test.

Accession	Height (cm)	Diameter (mm)	Canopy width (cm)
Baobab non-kene	66.6±8.4b	26.4±4.4a	42.1±8.7bc
Jujub-3A	97.7±13.2ab	13.4±1.9abc	72.3±10.1a
Jujub-Gola	133.2±15.5a	13.4±2.2bc	90.9±13.6a
Jujub-ICRAF08	98.6±12.9ab	12.0±1.6bc	53.2±8.2abc
Vitellaria Samanko-ka	11.18±1.5c	10.9±0.8bc	24.8±2.6c
Tamarin Gros-fruit	89.5±8.2ab	19.6±1.9ab	73.8±7.9a
Tamarin Niger-309	66.9±8.5b	10.9±1.0c	54.7±5.7ab
Tamarin Sucré	79.3±7.6b	13.7±1.3abc	59.6±6.6a

Table 7. Main effects of species on growth parameters of grafted and non-grafted plants of *Adansonia digitata* and *Vitellaria paradoxa* planted in Mali. Mean ± SE followed by the same letter are not significantly different at the 5% level according to Tukey's multiple comparison test.

Species	Height (cm)	Diameter (mm)	Canopy width (cm)
Adansonia digitata	45.1±1.3a	11.8±0.6a	11.6±1a
Vitellaria paradoxa	13.2±0.7b	5.5±0.4b	15.6±1.1a

Table 8. Growth parameters monitored on 4 accessions of *Tamarindus indica* planted in 2014, Mali. Mean ± SE followed by the same letter are not significantly different at the 5% level according to Tukey's multiple comparison test.

Accession	Height (cm)	Diameter (mm)	Canopy width (cm)
Gros-fruit	22.2±1.2b	5.3±0.4a	13.7±0.9b
Niger-309	22±1.3b	4.7±0.3a	13.7±1b
non-greffé	27.7±1.4a	5.1±0.2a	19.5±1a
Sucré	25±1.9ab	5.5±0.4a	16±1b

Table 9. Growth parameters monitored on improved 5 accessions and non-grafted seedlings of *Ziziphus mauritiana* planted in 2014, Mali. Mean ± SE followed by the same letter are not significantly different at the 5% level according to Tukey's multiple comparison test.

Accession	Height (cm)	Diameter (mm)	Canopy width (cm)
Jubjub 3A	31.1±2.4ab	4.8±0.4ab	15.3±1.5b
Jujub Ben-Gurion	32.9±2.6ab	5±0.3ab	22.1±2.1ab
Jujub Gola	35.7±2.4a	4.4±0.2ab	21.5±1.7a
Jujub ICRAF08	28.1±2.1ab	4.8±0.4ab	19.7±2.1ab
Jujub Umran	33±2.6ab	5.2±0.4a	18.4±1.7ab
Jujub non-greffé	27.3±1.9b	3.9±0.4b	18.2±1.7ab

Table 10 Sorghum-cowpea intercropping:

Treatment			Yield (kg/ha)				LER		
Cropping system	Cowpea variety	Sorghum variety	Sorghum grain		Cowpea haulm		pLERs	pLERc	Total LER
			Mean	SE	Mean	SE			
Sole cropping	None	Local	229	113	-	-	-	-	-
	None	Soumalemba	232	69	-	-	-	-	-
	Local Dunanfana	None	-	-	2,861	896	n.a.	n.a.	n.a.
		None	-	-	6,639	2,670	n.a.	n.a.	n.a.
Additive intercrop	local	Soumalemba	279	89	712	298	1.23	0.23	1.46
	Dunanfana	Soumalemba	185	61	2,986	1,603	0.78	0.40	1.18
Replacement intercrop	Local	Soumalemba	243	66	1,587	686	1.24	0.58	1.82
	Dunanfana	Soumalemba	176	39	4,882	1,374	1.02	1.10	2.12

Table 11 Sibirila economic analysis:

Fertilizer dose	Without compost			With compost		
	0	**125 kg/ha**	**250 kg/ha**	**0**	**125 kg/ha**	**250 kg/ha**
Mean yield (kg/ha)	**816**	**1386**	**1508**	**1035**	**1572**	**2017**
Total costs	**45925**	**75615**	**105300**	**45925**	**75615**	**105300**
Land preparation	20000	20000	20000	20000	20000	20000
Fertilizer	0	29690	59375	0	29690	59375
Herbicides/Pesticides	25925	25925	25925	25925	25925	25925
***Binkemefakalan* (Glyphosate or other pre-emergence herbicide)**	6500	6500	6500	6500	6500	6500
***dugu koli* (Furadan, at platning)**	13425	13425	13425	13425	13425	13425
***koorofangalan* (Selective post-emergence herbicide, Nicomaïs)**	6000	6000	6000	6000	6000	6000
Threshing: 1 in 10 sacks paid to thresher						
Sacks harvested (after paying threshing costs)	7	12.5	**13.5**	**9**	**13.5**	**18**
Price per sack: 6000 FCFA						
Earnings from maize sales	**42000**	**75000**	**81000**	**54000**	**81000**	**108000**
Profit (Earnings – Total costs)	**-3925**	**-615**	**-24300**	**8075**	**5385**	**2700**
For the highest-yielding trial:						
Sacks harvested (after paying threshing costs	20	23	48	33	40	52
Price per sack: 6000 FCFA						
Earnings from maize sales	120000	135000	288000	195000	237000	312000
Profit after paying costs	74075	59385	182700	149075	161385	206700
Costs per sack of maize harvested (At average yields)	**6561**	**6049**	**7800**	**5103**	**5601**	**5850**

Table 12. Summary of the different types of existing local conventions on natural resources management in the study sites

District	Interviewed Group	Name of the local convention	Written/ Oral	Date of establishment	Natural resources addressed and key conventions issues	Coverage
Koutiala	Local administrative authority	SIWAA	Written	May 1997 (formalization date)	Land, common pasture, forest, transhumance, conflict management, bush fire, hunting	Inter-District
	Sirakéle Community	CPC	Oral	Since the creation of the village	Forest - protection of sacred trees and community forest, regulation of harvesting of tree products by indigenes and foreigners, rules for harvesting Néré and shea butter, periods for harvesting wild fruits	Village
		CGC	Oral	Since the creation of the village	Conflict over land, pasture, transhumance - processes for mediation and resolution of conflict among the indigenes and foreigners over land, water and grazing, fines and sanctions for the offenders, permission for grazing crop residues after harvesting whether for transhumant herders or community members, conditions of accepting transhumant herders in the community, duration of stay of transhumant herders in the territory, period for entering grazing lands, protection of livestock corridors.	Village
		CGPE	Written	2007	Water – rule of access to the watering point, management of watering point and charges for use by foreigners, processes for conflict mediate over watering point	Village
	Namposséla Community	SIWAA	Written	1989	Land - rules of land ownership, rules of access to community land and acquisition by foreigners, protection of sacred land, organization and clearing modalities.	Inter-District

					Communal pastures – rules of access and use, management of communal pastures, protection from cropping. Forest – rules for cutting and sale of wood, quotas for harvesting forest resources for use as timber and fire wood. Transhumance - Demarcation of livestock routes in the community, arrival date of transhumant herders and duration of stay in the community. Conflict management – processes for mediation and resolution of conflict among the indigenes and foreigners over land, water and grazing. Bush fire - agenda for controlled bush fire and prohibition of uncontrolled bush fire, fine for uncontrolled bush fire Hunting - protection of some wildlife species, precision about species that could be hunted, date for community group hunting	
		KOMO	Oral	Since the creation of the village	Fishing: Protection of fish species, restriction of fishing in certain period of the year, fixing of the period of fishing by community leaders and communication to community members	Village
		CAT	Oral	Since the creation of the village	Land use and management - land tenure and security, condition of access to land by foreigners, and transfer of land among the community members	Inter-Village
	Zanzoni Community	CGT	Oral	Since the creation of the village	Transhumance – protection of livestock routes in the community, conditions for receiving transhumant herders in the village territory, arrival date and duration of stay in	Village

					the community, resolution of conflict between herders and the community members, permission to graze crop field by the transhumant herds	
		CGC	Oral	Since the creation of the village	Conflict over land use, communal pasture and water - processes for mediation and resolution of conflict among the indigenes and foreigners over land, water and grazing; fines for the offenders and compensation for the victims in case of damage to crops	Village
		CTT	Oral	Since the creation of the village	Land use and management - land tenure and security, condition of access to land by foreigners, and transfer of land among the community members	Village
		CGF	Oral	2003	Forest - conditions of cutting and sale of fuelwood, rules and roles for monitoring of community forest	Inter-district
Bougouni	Local administrative authority	CGRN	Written	November 2010	Land, common pasture, forestry, water, conflict, bush fire, wild resources (fauna and flora, wild fruit)	Inter-district
		CPC	Oral	Since the creation of the village	Wild fruit harvest	Inter-village
		CAP	Oral	2006	Land use and forest - land tenure and security, condition of access to land by foreigners, protection of sacred forest, rules for cutting of trees in community forest and protection of certain tree species	Inter-Village
	Sibilira Community	CGF	Oral	1993	Forest – rules for cutting trees for fuel-wood and prohibition of sale of fuel-wood	Village
		CGPC	Oral	2011	Pasture - access and use of grazing areas, prohibition of cropping on grazing land conflict management - processes of conflict resolution, precision of sanctions.	Village

	Yorobougoula Community	CGRN	Written	November 2010	Land, pasture, forest – modalities for exploitation of forest resources, protection of pasture for animal, harvesting of forest product, rules for sale of woods, conditions of harvesting wild fruits and fixing of harvesting period of wild fruits. Water, conflict management, bush fire – access to watering points, processes for conflict mediation, rules for controlled bush fire, sanctions for uncontrolled bush fire. Hunting - management modalities: hunting license, fixation of hunting period, and rules for ritual hunting)	Inter-District
		CGF	Oral	2007	Forest - management of protected area. hunting, bush fire – rules for controlled bush fire	Inter-Villager
	Diéba Community	CGF	Oral	Since colonial period	Forest - conditions for cutting of fuel wood	Village
		CGP	Oral	In the 1960s	Pasture - access and use of grazing area	Village
		CGM	Oral	Since the creation of the village	Ponds with various fish species - management system, fixing period for fishing	Village

Acronyms: SIWAA (SIWAA Convention); CGPE: Convention on management of watering points, CGT: Convention on land allocation - land tenure security, CPC: Convention on the regulation of wild fruits, CGC: Convention on conflicts management, KO-MO Convention on collective fishing, CGT: Convention on transhumance management, CTT: Convention on land tenure, CGF: Convention on forestry management, CGRN: Convention on natural resource management, CAP: Convention on Protected Areas, CGPC: Convention on rangeland and conflicts management, CGP: Convention on rangeland management, CGM: Convention on standing pools management.

Table 13. Level of knowledge of local conventions by the respondents in Bougouni and Koutiala

District	Average	Male	Female
Bougouni	3.16±1.21	3.47±0.96	2.50±1.44
Koutiala	1.70±1.44	1.81±1.46	1.57±1.38

Rating (0 = none, 1 = low, 2 = average, 3 = good, 4 = very good)

Table 14. Participation in the elaboration processes of existing local conventions in the study sites by gender

Variable	Bougouni		Koutiala	
	Male(N=52)	Female(N=24)	Male(N=59)	Female(N=30)
Diagnosis	1.52±0.22 [a]	0.50±0.22[b]	0.98±0.18 [a]	0.27±0.13[b]
Awareness	1.40±0.21 [a]	0.46±0.21[b]	0.86±0.17 [a]	0.20±0.10[b]
Resource mobilizations	0.07±0.06	0	0.31±0.10 [a]	0.07±0.05[b]
Formalization	0.27±0.06 [a]	0.08±0.08[b]	0.37±0.09 [a]	0.07±0.05[b]
Development	0.56±0.12 [a]	0.04±0.04[b]	0.53±0.12 [a]	0.07±0.05[b]

The score for the level of participation was 0 = none, 1 = low, 2 = average, 3 = high, 4 = very high. Means in the same row with different superscript letters are statistically different at $P < 0.05$

Table 15. Results of the regression analysis of the level of participation of community members in the elaboration processes of local conventions in the study sites

Independent variable	Bougouni					Koutiala				
	Diagnosis	Awareness	Resources	Formalization	Development	Diagnosis	Awareness	Resources	Formalization	Development
Age	0.07***	0.05***	0.02***	0.02***	0.03***	0.02*	-0.01	0.01	0.01**	0.01
Residence	-0.01	-0.01	-0.02***	-0.01	-0.02***	0.01***	0.02***	0.01*	0.01	0.01**
Female	-0.65*	-0.75**	-0.21**	-0.10	-0.53***	-0.34*	-0.36	-0.07	-0.18	-0.16
Illiterate	-0.14	-0.29	0.06	-0.14	0.13	-0.07	-0.28	0.18	0.08	-0.08
Secondary	-2.04**	-2.14**	-0.33	-0.52	-0.92*	0.95	0.29	1.01***	0.63**	1.15***
Koranic	0.60	-0.21	-0.06	0.11	0.28	0.67	0.62	0.79**	0.29	0.39
Minianka	2.53**	2.52**	-0.43*	-0.19	1.05*	-0.88	-1.16*	-0.02	-0.29	-1.04**
Fulani	-0.88***	-1.02***	0.11	-0.25**	-0.25	-0.17	-0.20	0.24	-0.02	-0.70
Constant	-1.51**	-0.29	-0.20	-0.35	-0.35	0.23	1.39*	-0.36	-0.05	0.80
R^2	0.47	0.37	0.33	0.26	0.26	0.21	0.21	0.21	0.15	0.24

*** Significant at the 1 % level, ** significant at the 5 % level, * significant at the 10 % level

Table 16. Suggestions for effective implementation of local conventions according to administrative and community leaders interviewed in the study sites

Suggestion
1. Translation of written local conventions into local languages
2. Strengthening the capacity of different stakeholders at all levels
3. Establishing framework for dialogue between the community, technical services and administrative services
4. Establishment of a committee to mobilize financial resources
5. Formalization of existing oral local conventions
6. Strengthening dialogue and consultation within the community
7. Promoting the participation of all stakeholders by ensuring adequate representation of all groups when developing local conventions
8. Strengthening mechanisms for information sharing to ensure good understanding of the content of local conventions by local stakeholders
9. Ensuring regular reminder of the content of local conventions
10. Establishment of rules consistent with the realities on the ground and changing socio-cultural contexts
11. Provision of technical and financial support

Table 17: Profile of the 28 FO in Bougouni and Yanfolia watershed villages

	N	Minimum	Maximum	Mean	Std. Deviation
Farmer organizations	28	0	12	6.00	2.568
Age of the president	28	34	75	50.86	8.648
Members in Farmer Organization	23	10	2000	135.57	407.945
Number of years since establishment (years)	28	3	39	13.86	9.474

Table 18: Fertiliser Use in Bougouni/Yanfolila watershed villages (Kg/ha)

Crop	Mean	N	Std. Deviation	Minimum	Maximum	First	Last	Variance
Cotton	195.0	10	36.9	100.0	250.0	200.0	200.0	1361.1
Maize	225.0	2	35.4	200.0	250.0	250.0	200.0	1250.0
Groundnut	28.0	2	2.8	26.0	30.0	30.0	26.0	8.0
Sorghum	125.0	2	35.4	100.0	150.0	150.0	100.0	1250.0
Total	169.1	16	69.0	26.0	250.0	200.0	200.0	4761.6

Table 19: ANOVA Fertiliser kg/ha

		Sum of Squares	df	Mean Square	F	Sig.
Fertiliser Kg/ha * Crop	Between Groups (Combined)	56665.8	3	18888.6	15.4	0.0
	Within Groups	14758.0	12	1229.8		
	Total	71423.8	15			

Table 20 : Training schedule for rainy season 2014 Farmer Field school sessions with groundnuts and cowpea varieties and agronomic practices, with the themes and topics of the discussion.

Thèmes de formation	Participants M'Pèssoba		Participants Sirakélé	
	Hommes	Femmes	Hommes	Femmes
Mise en place des parcelles de tests variétaux et agronomiques Thème de nutrition : groupes d'aliments et la vitamine A lors du semi (copie de message distribuées)	5	106	6	149
Entretien des parcelles d'essais expérimentaux Thème de nutrition abordé : Importance du fer et l'iode et les sources disponibles (copie de message distribuées)	5	100	6	140
Pratique de l'évaluation des variétés et options agronomiques dans des tests. Thème de nutrition abordé : Importance des feuilles vertes.	5	133	6	124
Préparation du produit de traitement du Niébé à base de feuille de Neem Thème de nutrition abordé : Importance des feuilles de Niébé dans la nutrition	5	104	6	99
Pratique de la récolte des tests variétaux et agronomiques de Niébé Thème de nutrition abordé : Importance des feuilles vertes	5	133	6	124
Récolte et gestion post récolte de l'arachide	4	103	6	108
Participation totale	29	697	30	73

Table 21: Program of Nutrition Field School Sessions during the dry season:

Date	Thème	Village	Responsable	Appui
09/02/15	Alimentation des enfants de 06 à 23 mois	M'Pèssoba	Pierre Coulibaly (AMEDD) Assata Kayentao (AMASSA)	ICRISAT, AVRDC
11/02/15	Alimentation des enfants de 06 à 23 mois	Sirakele	Pierre Coulibaly (AMEDD) Assata Kayentao (AMASSA)	ICRISAT, AVRDC
16/02/15	Santé et nutrition des femmes enceintes et allaitantes	M'Pèssoba	Pierre Coulibaly (AMEDD) Assata Kayentao (AMASSA)	ICRISAT, AVRDC
18/02/15	Santé et nutrition des femmes enceintes et allaitantes	Sirakele	Pierre Coulibaly (AMEDD) Assata Kayentao (AMASSA)	ICRISAT, AVRDC
23/02/15	Alimentation des enfants malades	M'Pèssoba	Pierre Coulibaly (AMEDD) Assata Kayentao (AMASSA)	ICRISAT, AVRDC
25/02/15	Alimentation des enfants malades	Sirakele	Pierre Coulibaly (AMEDD) Assata Kayentao (AMASSA)	ICRISAT, AVRDC

Table 22: Overall analysis of variance of cowpea trials conducted in Sirakele village.

Fixed term	Wald statistic	n.d.f.	F statistic	d.d.f.	F pr
Pratique	5.59	1	5.59	27.0	0.025
Variete	72.18	4	18.05	27.0	<0.001
Pratique.Variete	3.06	4	0.76	27.0	0.558
Quartier	19.19	3	6.40	27.0	0.002

Moyenne générale : 423.2 kg/ha , Standard error: 24.8

Table 23: Analysis of variance for cowpea trials from 3 fields in M'pessoba village in 2014.

	Wald statistic	n.d.f.	F statistic	d.d.f.	F pr
Pratique	8.40	1	8.40	10.0	0.016
Variete	11.82	2	5.91	10.0	0.020
Pratique.Variete	0.90	2	0.45	10.0	0.651
Quartier	22.91	2	11.46	10.0	0.003

Moyenne générale : 578.7 Standard error: 49.1

Table 24 Choice of preferred cowpea variety for 3 quarters in each village

Village	**Quartier**	**Variétés préférée**
Mpèssoba	Kamoana	Wilibali
Mpèssoba	Dougolosso	Korobalen
Mpèssoba	Lassanbougou	Wilibali
Sirakele	Zibala	Maradi locale
Sirakele	Site central (TOT)	Korobale et Maradi locale
Sirakele	Karaba	Korobale

Table 25: Varietal choice by the different women groups in Sirakele village at flowering and at harvest.

Quartier	Rang	Evaluation à la levée	Evaluation at flowering	Evaluation at harvest	Criteria for preference
TOT	1	**ICGV 86124**	**ICGV 86124**	**ICGV 86124**	Plant stand density, plant vigour, abundance of flowers and large grains size
	2	ICGV 86024	ICGV 86024	ICGV 86015	
	3	ICGV 86015	ICGV 86015	ICGV 86024	
	4	Locale (témoin)	Locale (témoin)	Locale (témoin)	
	5	ICIAR 19BT	ICIAR 19BT	ICIAR 19BT	
Karaba	1	**ICGV 86124**	**ICGV 86124**	**ICGV 86124**	Plant stand density, abundance of flowers and large grains size
	2	ICGV 86015	ICGV 86015	ICGV 86024	
	3	ICGV 86024	ICIAR 19BT	ICGV 86015	
	4	Locale (témoin)	ICGV 86024	Locale (témoin)	
	5	ICIAR 19BT	Locale (témoin)	ICIAR 19BT	
Blendjoula	1	**Locale (témoin)**	**ICIAR 19BT**	**ICGV 86015**	Plant stand density, plant vigour, abundance of flowers and large grains size
	2	ICGV 86015	ICGV 86124	ICGV 86124	
	3	ICGV 86024	ICGV 86024	ICIAR 19BT	
	4	ICIAR 19BT	ICGV 86015	Locale (témoin)	
	5	ICGV 86124	Locale (témoin)	ICGV 86024	
Gnanziesso	1	**ICGV 86015**	**ICGV 86015**		Plant stand density, abundance of flowers
	2	ICGV 86024	ICGV 86024		
	3	ICIAR 19BT	ICIAR 19BT et ICGV 86124		
	4	ICGV 86124			
	5	Locale (témoin)	Locale (témoin)		

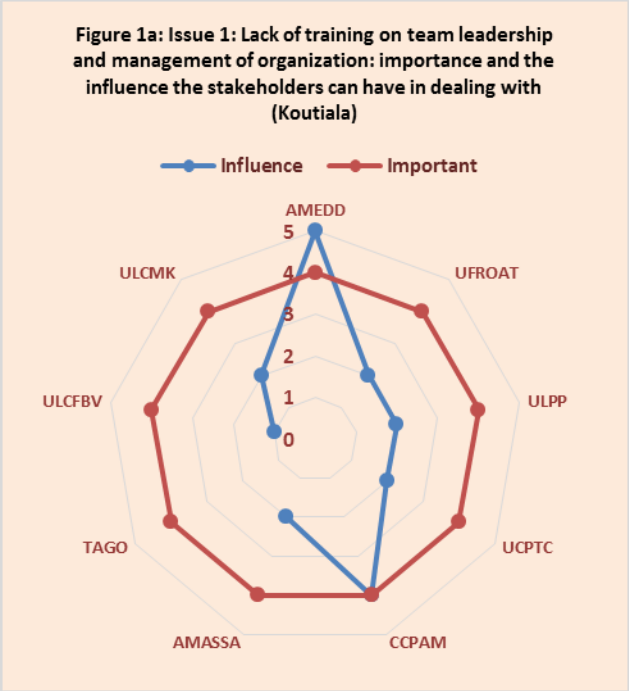


Figure 1a: Issue 1: Lack of training on team leadership and management of organization: importance and the influence the stakeholders can have in dealing with (Koutiala)
Influence
Important
AMEDD
UFROAT
ULPP
UCPTC
CCPAM
AMASSA
TAGO
ULCFBV
ULCMK
0
1
2
3
4
5

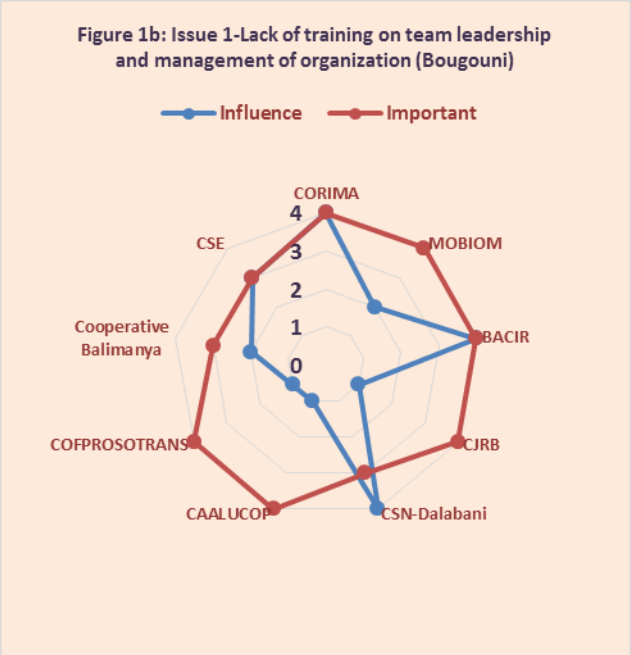


Figure 1b: Issue 1-Lack of training on team leadership and management of organization (Bougouni)
Influence
Important
CORIMA
MOBIOM
BACIR
CJRB
CSN-Dalabani
CAALUCOP
COFPROSOTRANS
Cooperative Balimanya
CSE
0
1
2
3
4

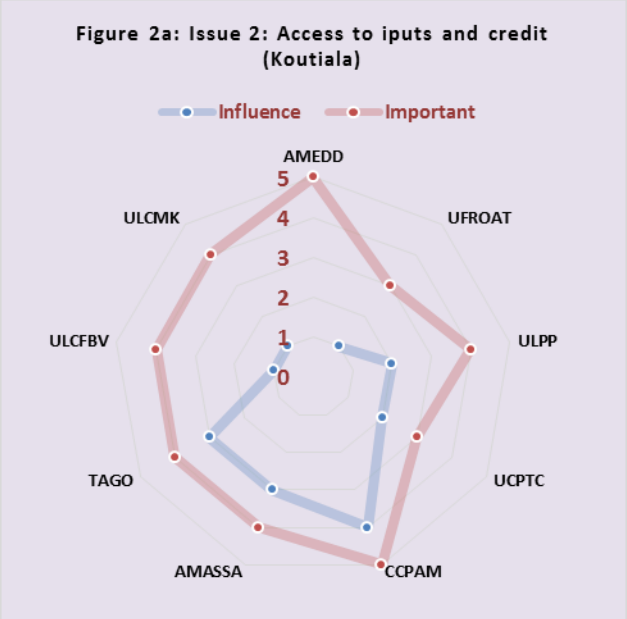


Figure 2a: Issue 2: Access to iputs and credit (Koutiala)
Influence
Important
AMEDD
UFROAT
ULPP
UCPTC
CCPAM
AMASSA
TAGO
ULCFBV
ULCMK
0
1
2
3
4
5

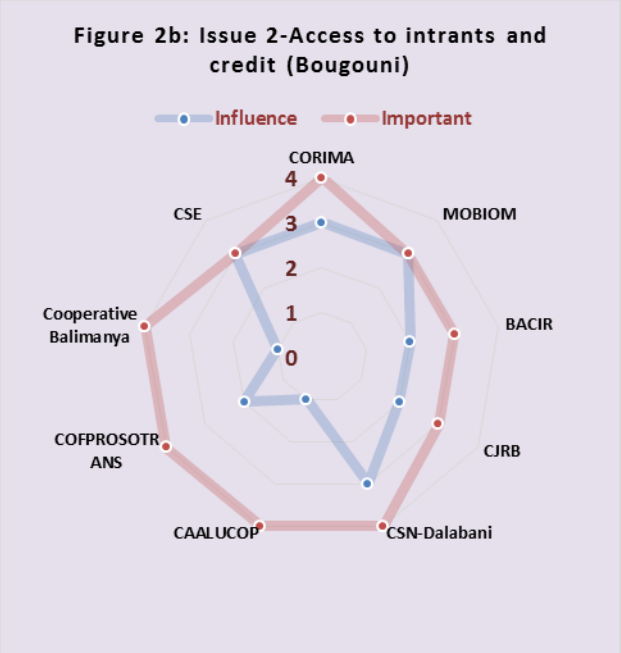


Figure 2b: Issue 2-Access to intrants and credit (Bougouni)
Influence
Important
CORIMA
MOBIOM
BACIR
CJRB
CSN-Dalabani
CAALUCOP
COFPROSOTRANS
Cooperative Balimanya
CSE
0
1
2
3
4

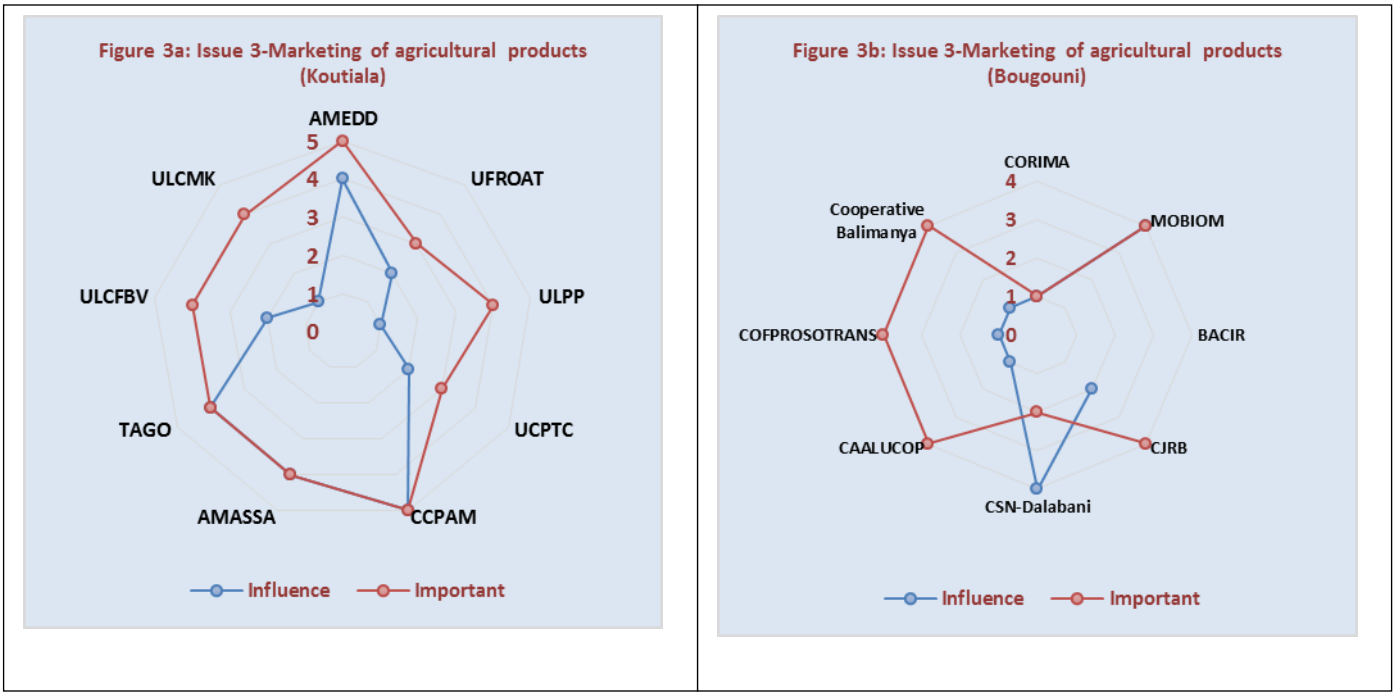


Figure 4: Collaboration network in Koutiala

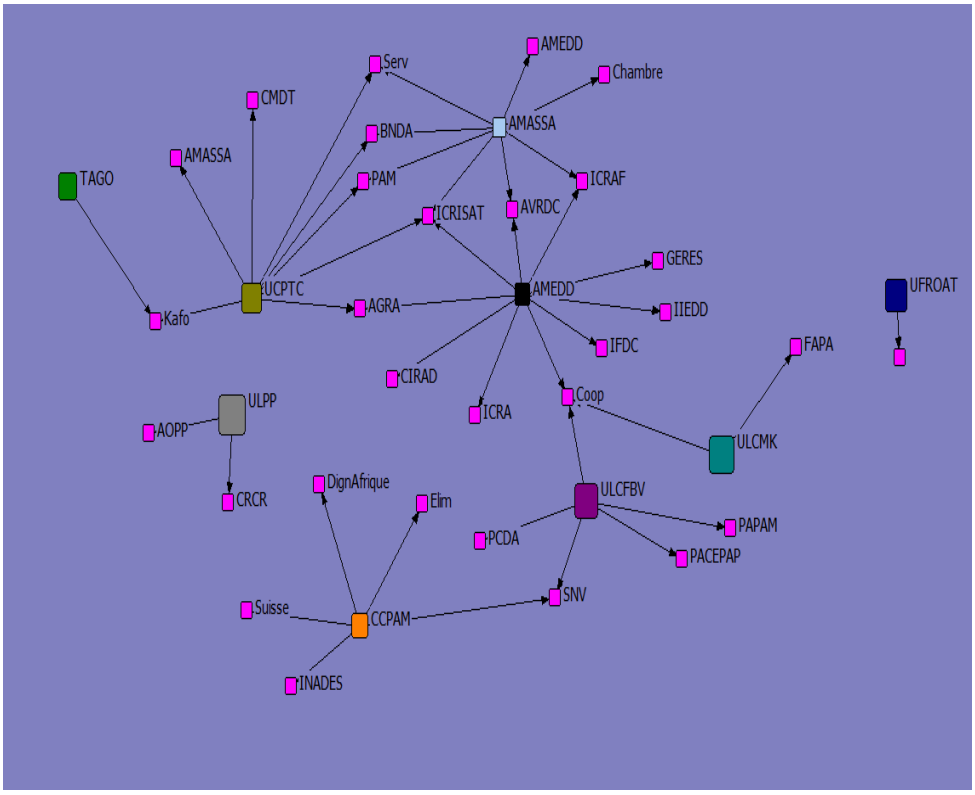
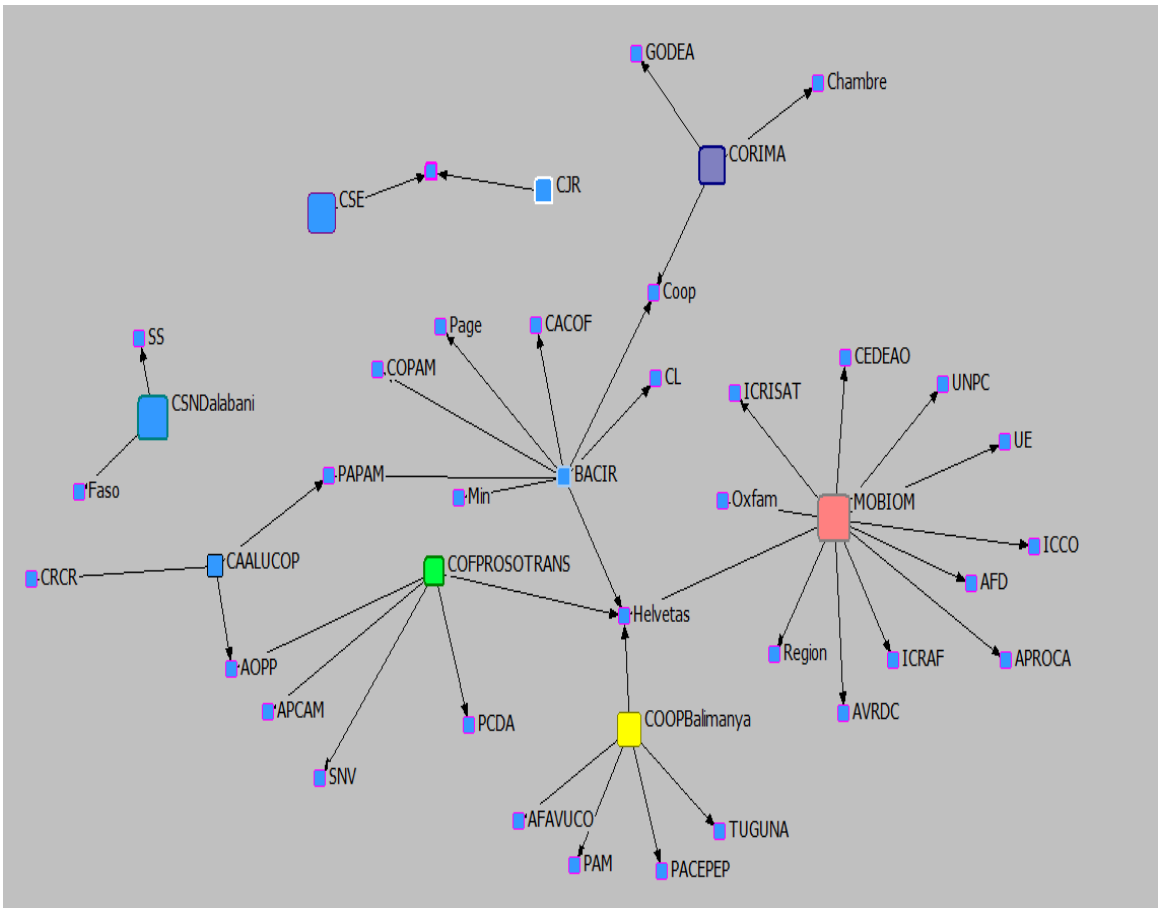
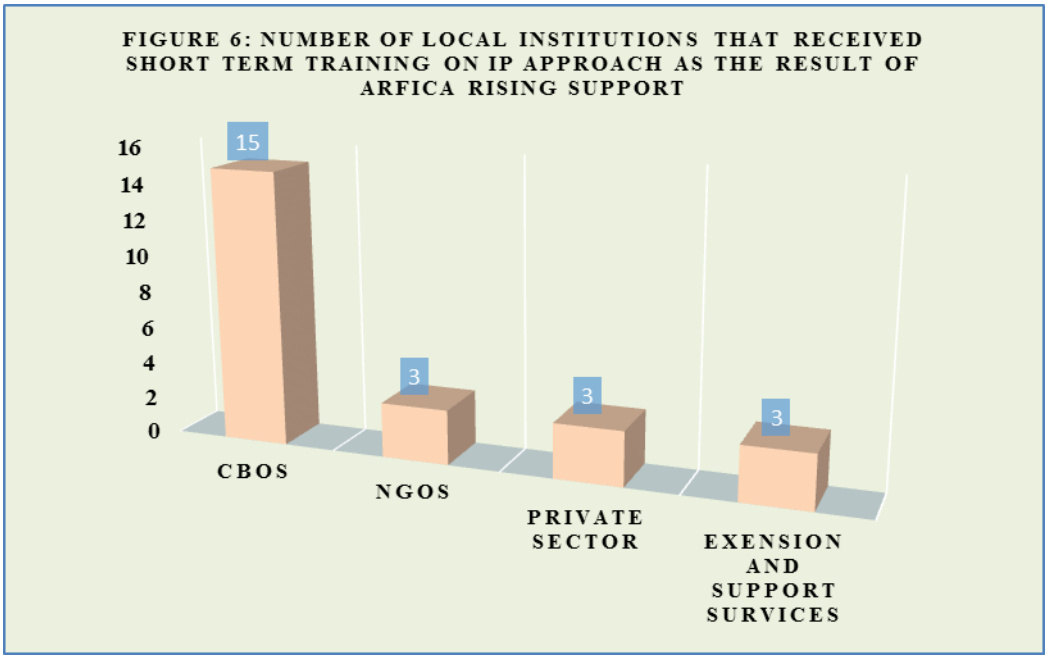


Figure 5: Collaboration network in Bougouni





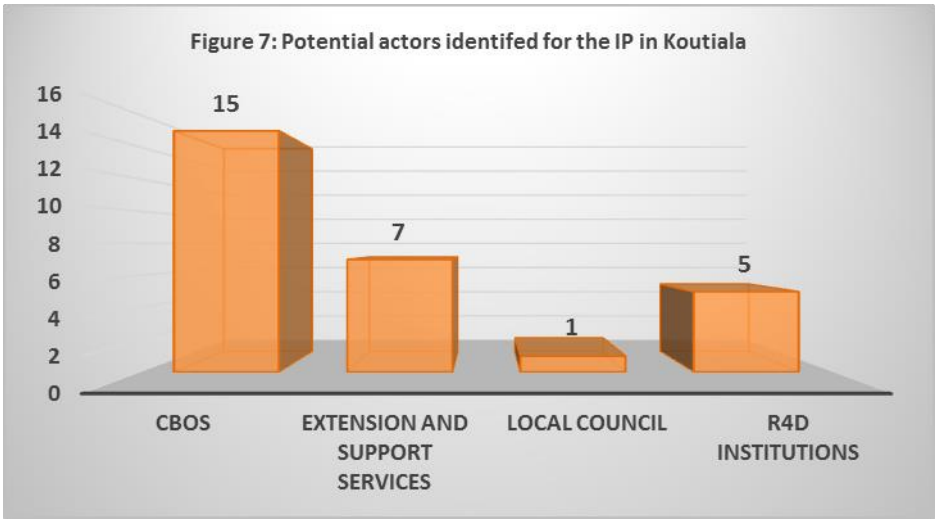


Figure 7: Potential actors identifed for the IP in Koutiala
16
14
12
10
8
6
4
2
0
15
7
1
5
CBOS
EXTENSION AND SUPPORT SERVICES
LOCAL COUNCIL
R4D INSTITUTIONS

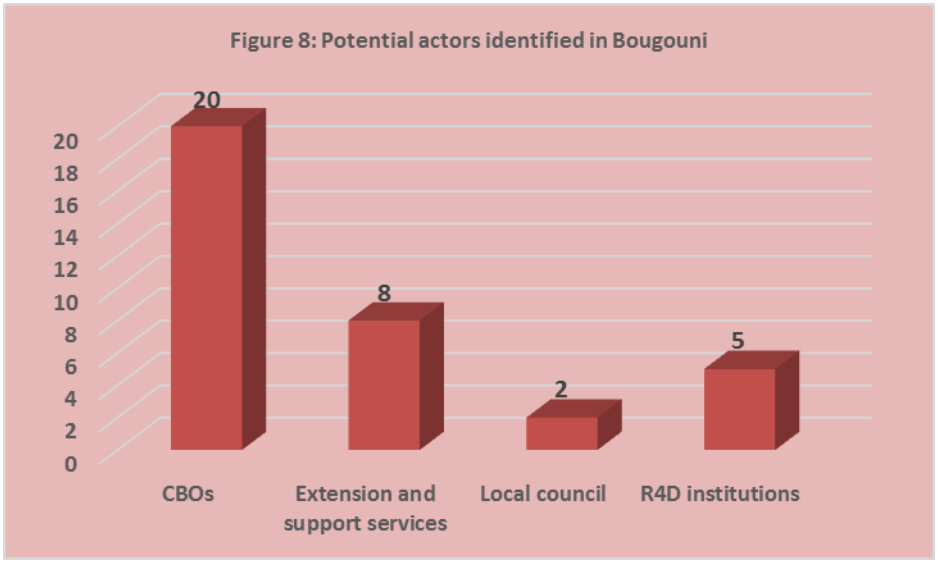


Figure 8: Potential actors identified in Bougouni
20
18
16
14
12
10
8
6
4
2
0
20
8
2
5
CBOs
Extension and support services
Local council
R4D institutions

Figure 9. Seasonal variation of tomato price in Bougouni and Koutiala market centers

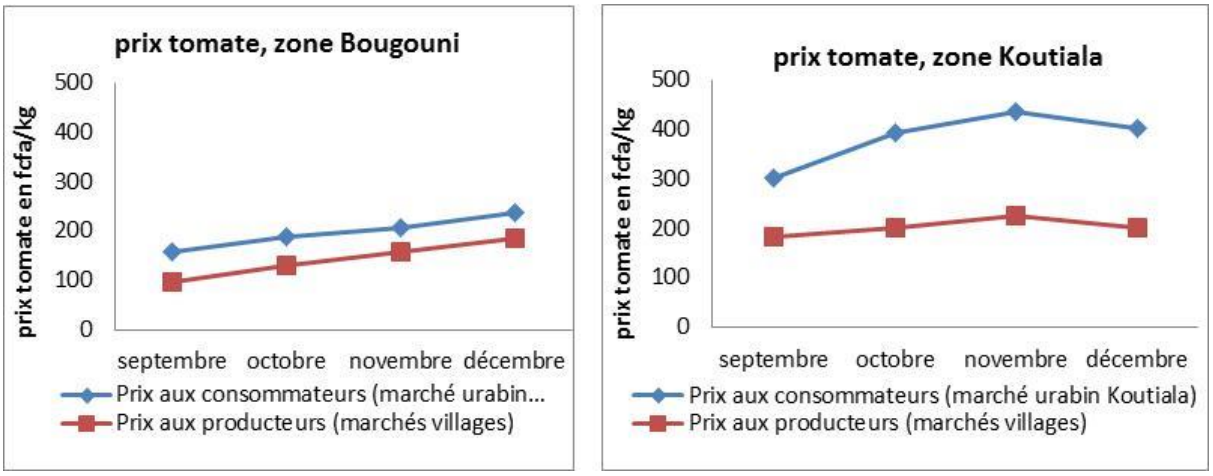


Figure 10. Seasonal variation of Sorghum price in Bougouni and Koutiala market centers

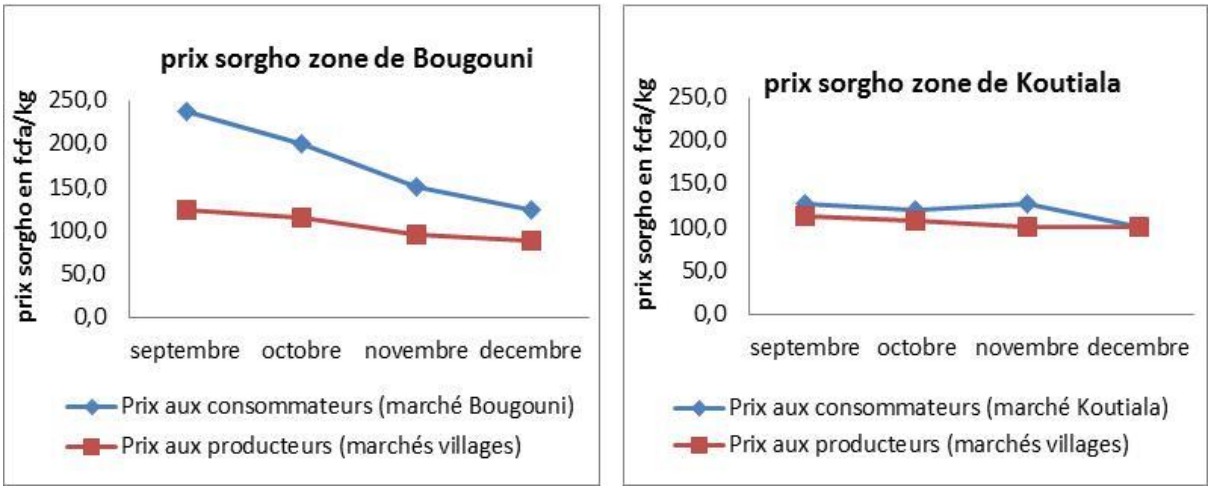


Figure 11: Ex-ante assesment of the effect of maize-cowpea intercropping adoption on fodder production and household (HH) food self-sufficiency for high resource endowed farms with a large herd (a) and for medium resource endowed farms (b).

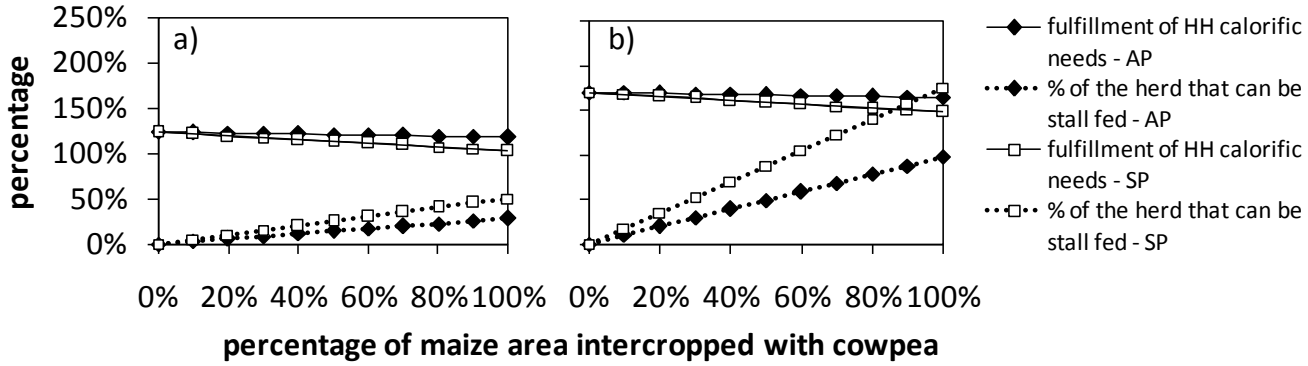


Figure 12: Ex-ante assesment of the effect of replacement of millet by cowpea grain variety on householf food self-sufficiency (FSS) and farmer net cash income for low resource endowed farms

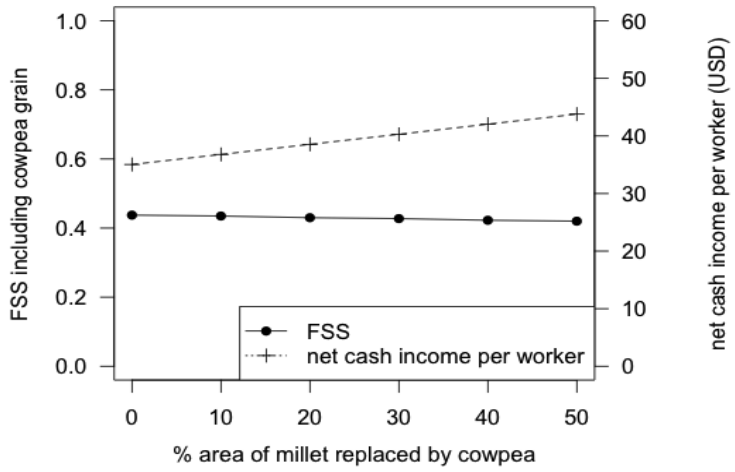


Figure 13. Mortality rate of scion and entire plants of 8 accessions grafted on seedlings of *Adansonia digitata* (Baobab), *Tamrindus indica* (Jujub) and *Tamarindus indica* (T) planted in 2013 in Mpessoba, Sibirila and Zanzoni. Mean ± SE followed by the same letter are not significantly different at the 5% level according to Tukey's multiple comparison test.

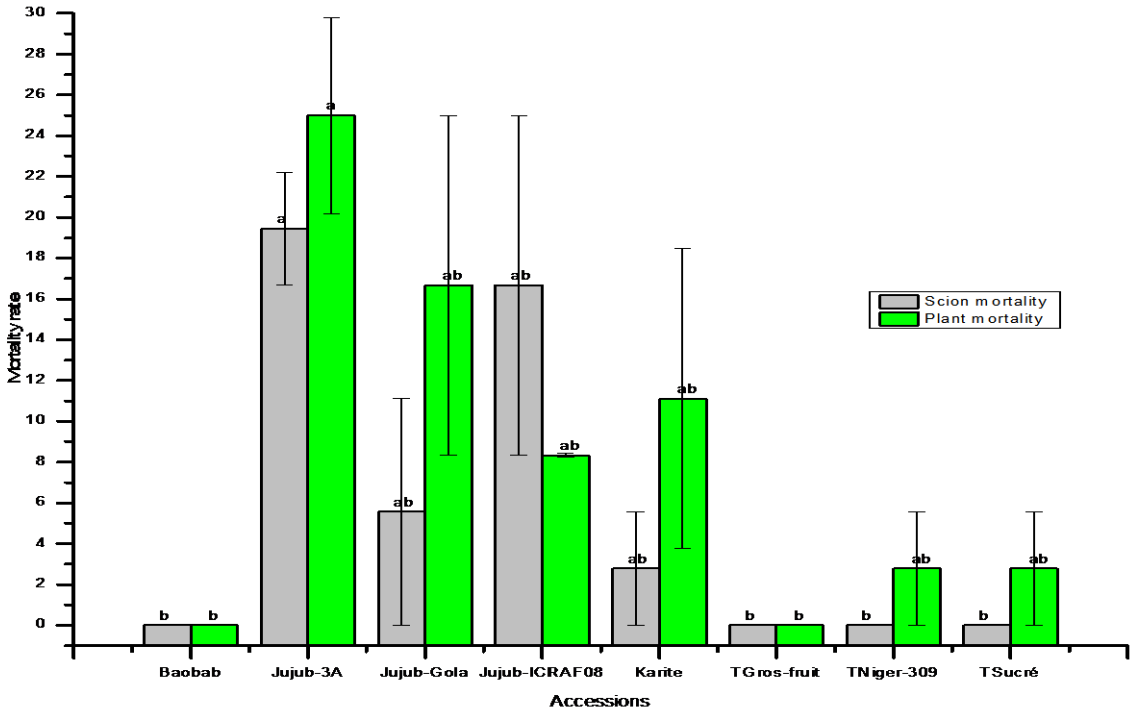


Figure 14: Groundnut Pod yield result

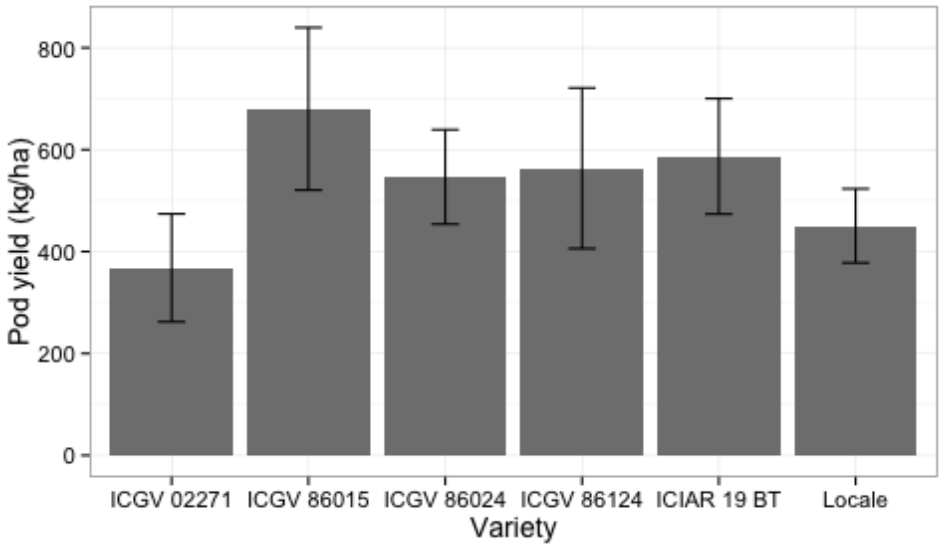


Figure 15: Grain Yield for Cowpea

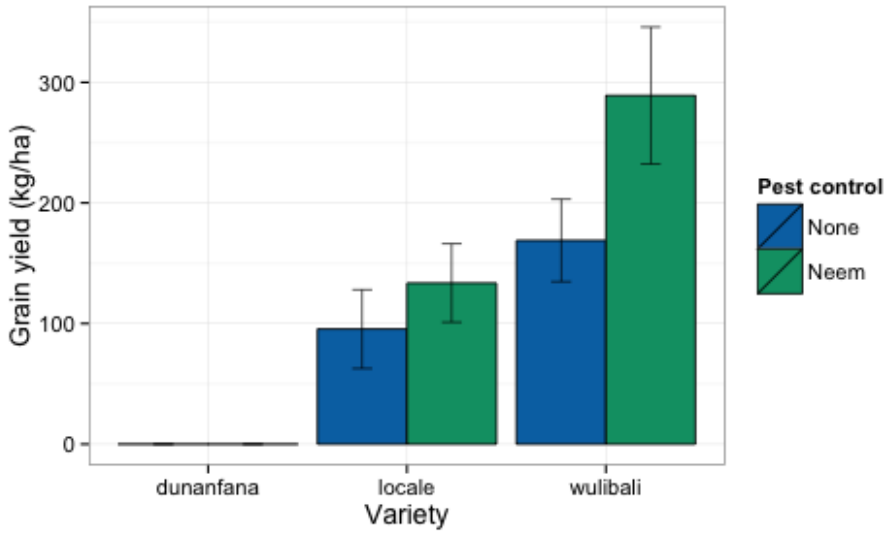


Figure 16: Halum Yield for Cowpea

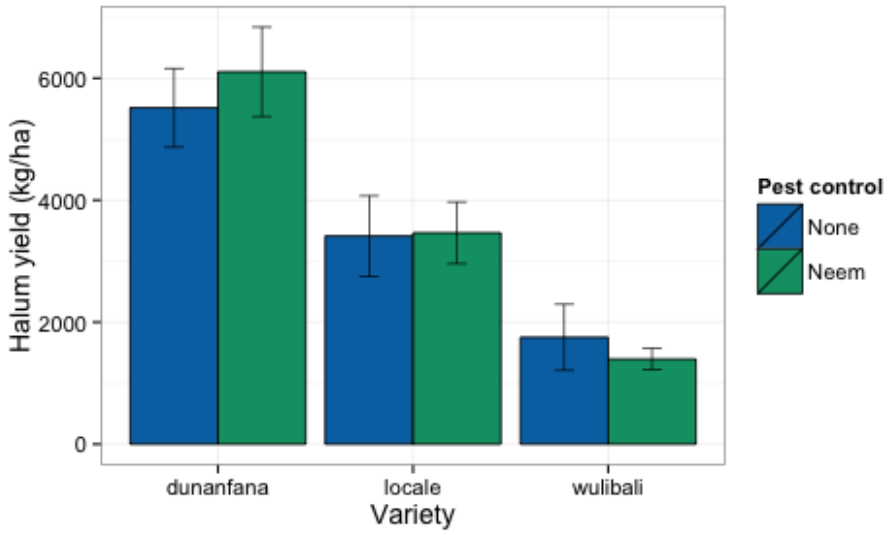


Figure 17: Yield for Maize

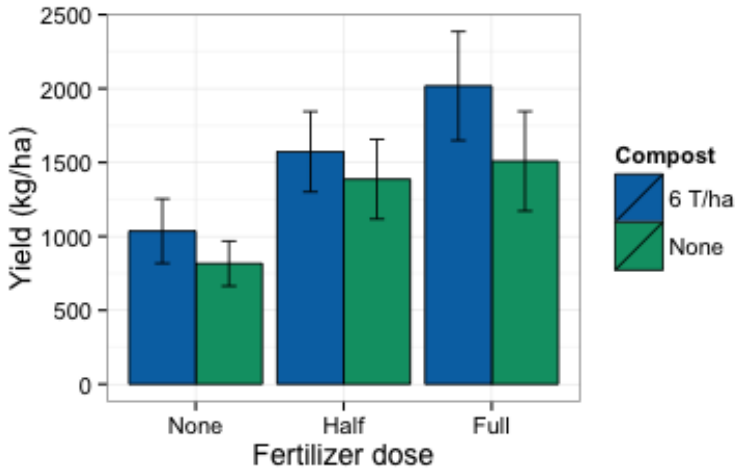


Figure 18. Level of knowledge of local conventions according to gender in Bougouni and Koutiala.

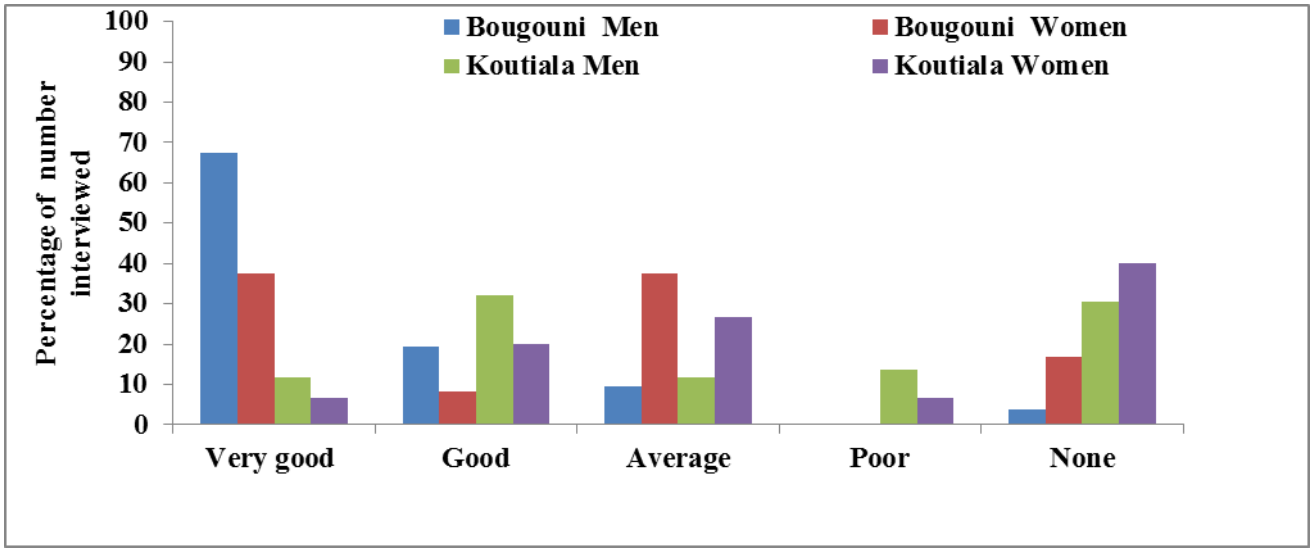


Figure 19a. Perceptions of the respondents on the benefits of local conventions in Bougouni.

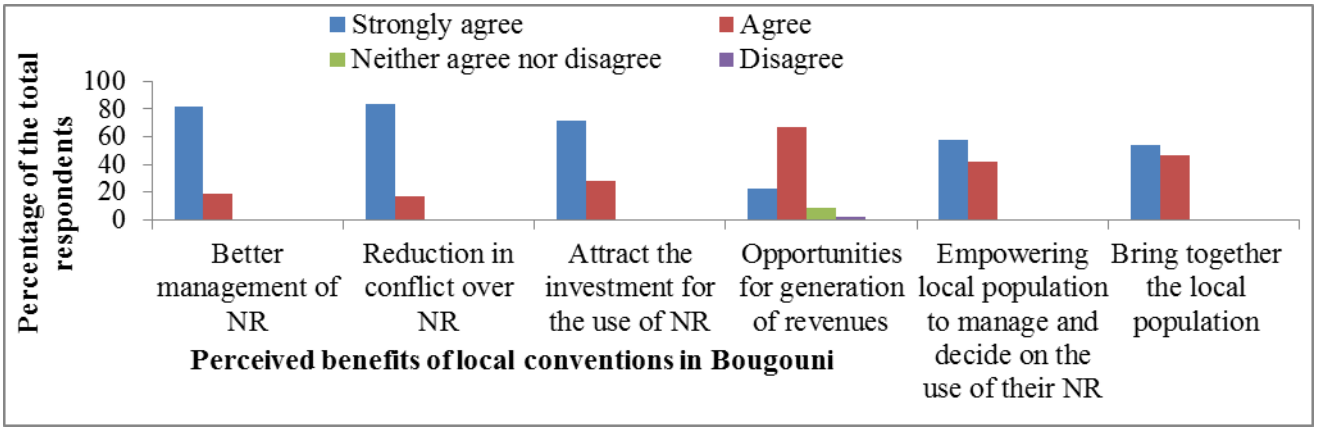


Figure 19b. Perception of the respondents on the benefits[4] of local conventions in Koutiala

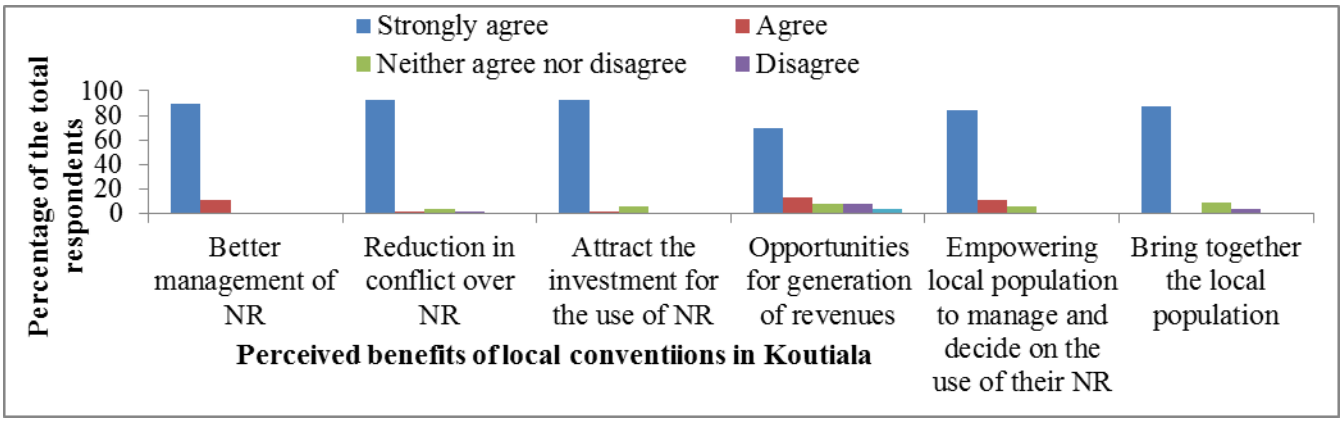


Figure 20: Illustration of causes of conflict

Key Message: The common feature of conflict is the presence of multiple nature resource actors (users) who focus on their interest only with little or no consideration for others**.**

Fisherman: Look! Those people who grow vegetable have moved our nets to another place in order for them to expand the area for vegetable production

Unbelievable! The animals have scattered our nets. We also have

Farmer said: I have to increase my farm area because the soil is no more fertile and I have to feed many people

For
the

Herder : What?
occupied the livest
think we have to ca
heads? And they hav
farm to the grazing
who is stronger!

Figure 21: Crop production in Bougouni/Yanfolila district

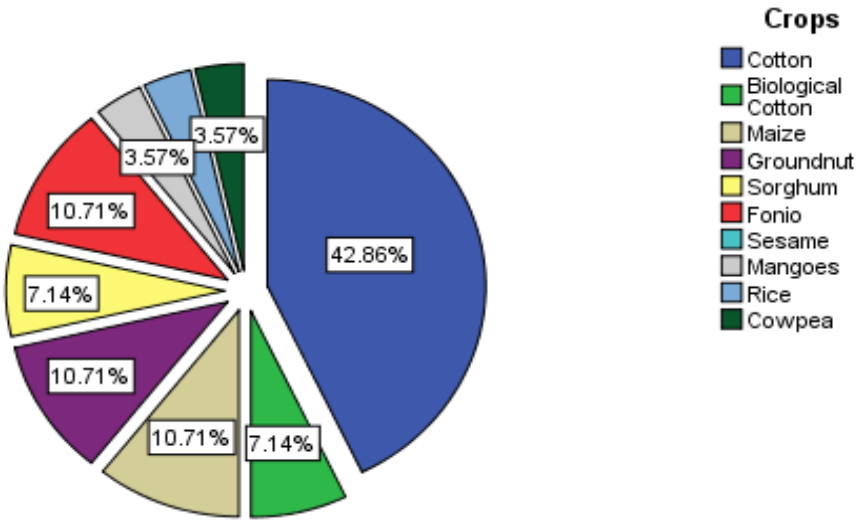


Figure 22 Crop yields in Watershed villages of Bougouni and Yanfolila

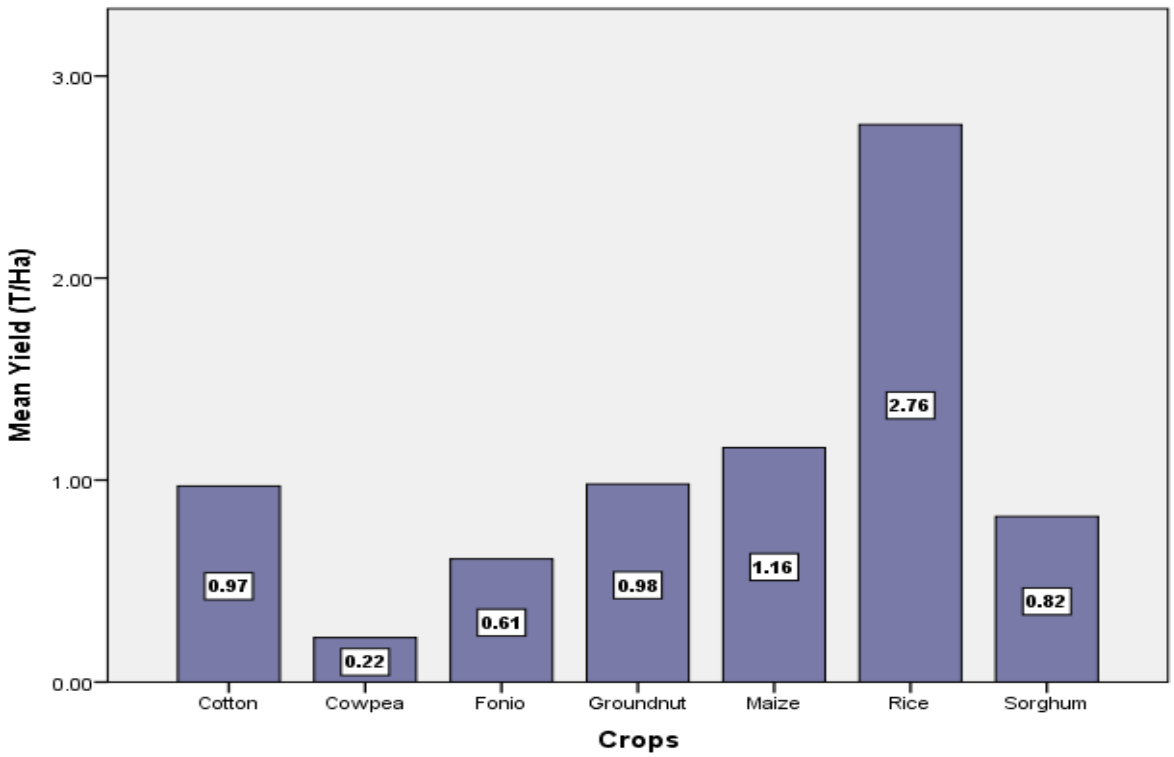


Figure 23: Seasonal variation of climatic data in Koutiala district (Data from 1980-2010)

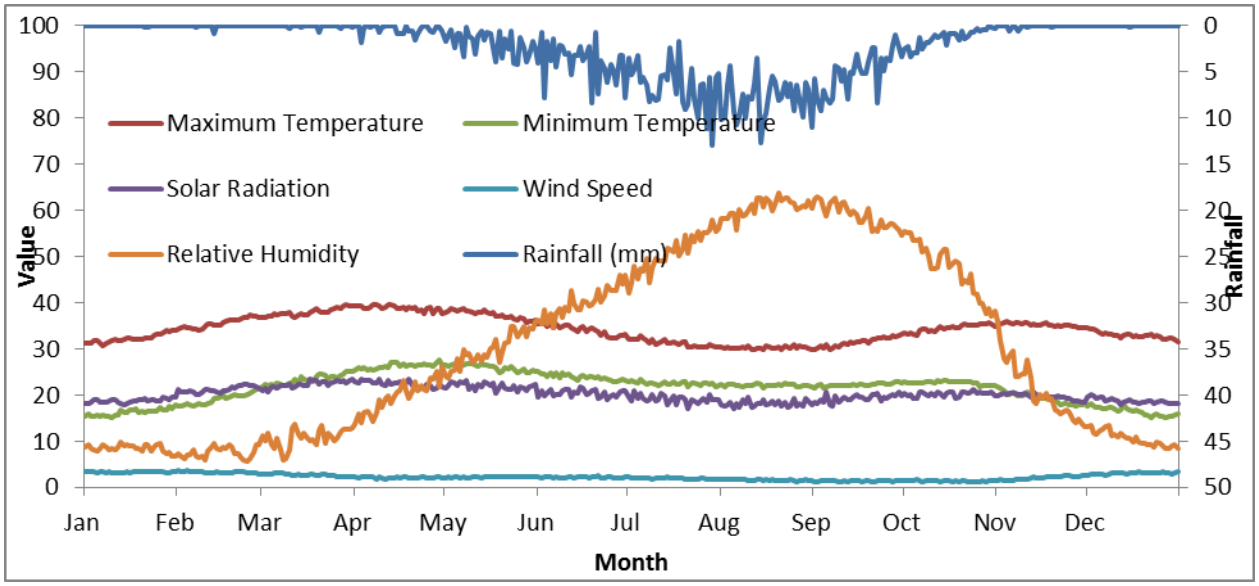


Figure 24: Seasonal rainfall and evaporation. Data from 1980-2010, Koutiala weather station

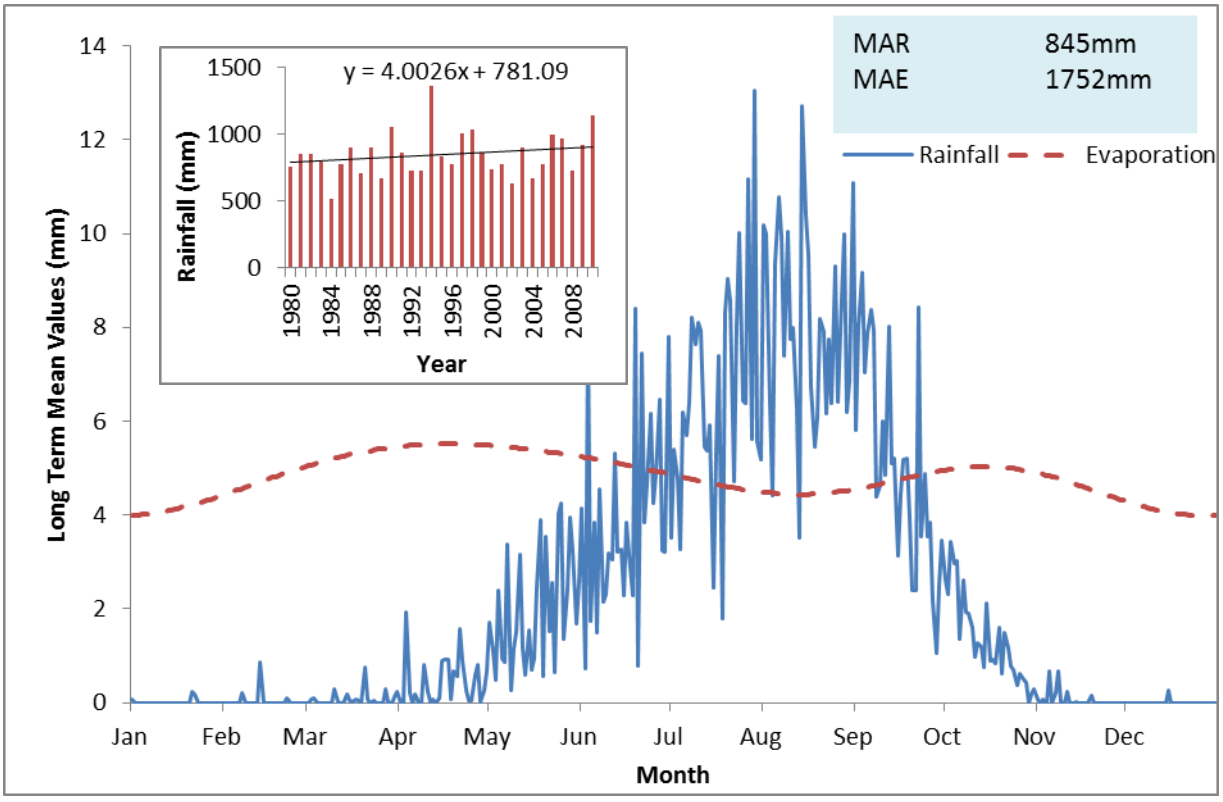


Figure 25: Source of water for household water demand

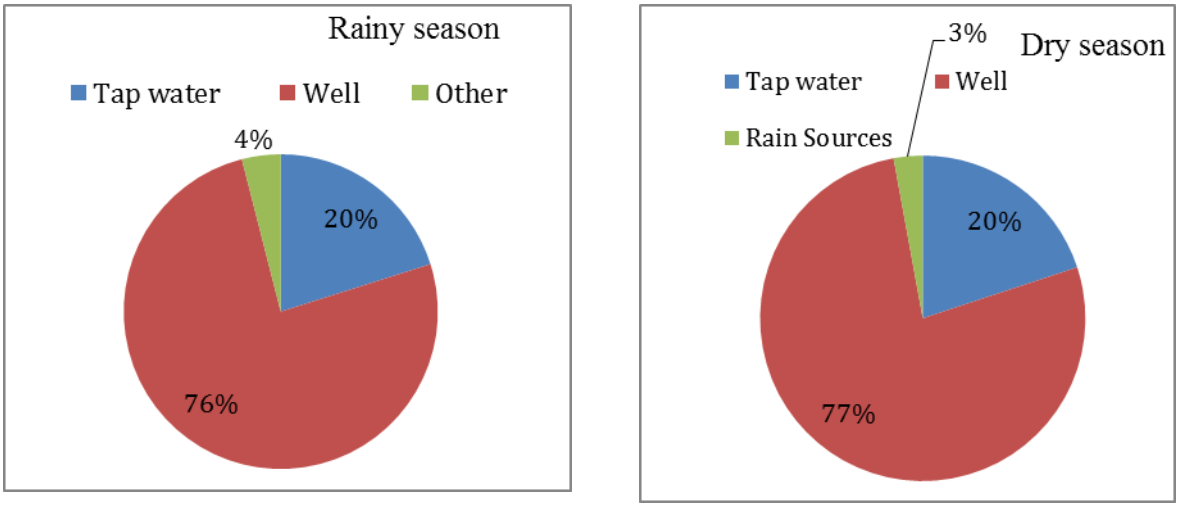


Figure 26 Shallow well construction history (a) Bougouni, (b) Koutiala

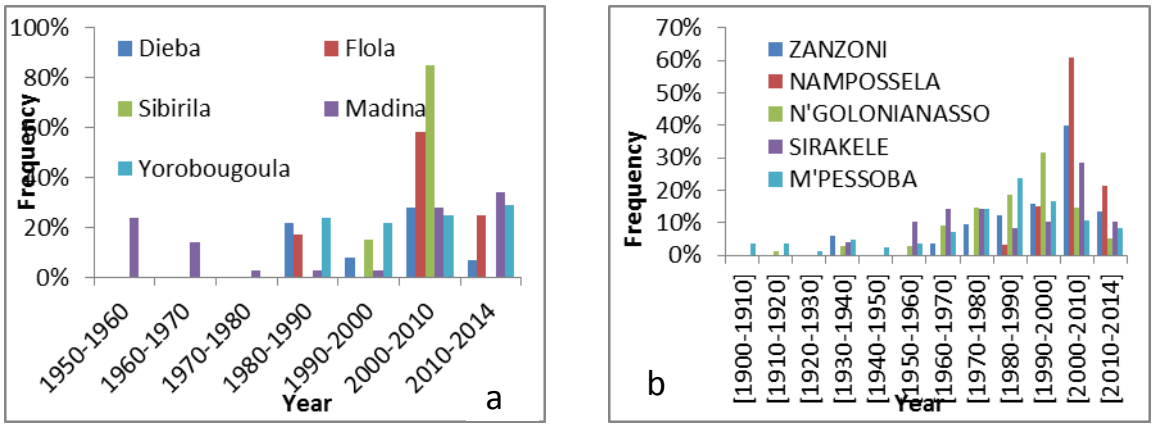


Figure 27: Depth of Shallow wells (a) Bougouni, (b) Koutiala

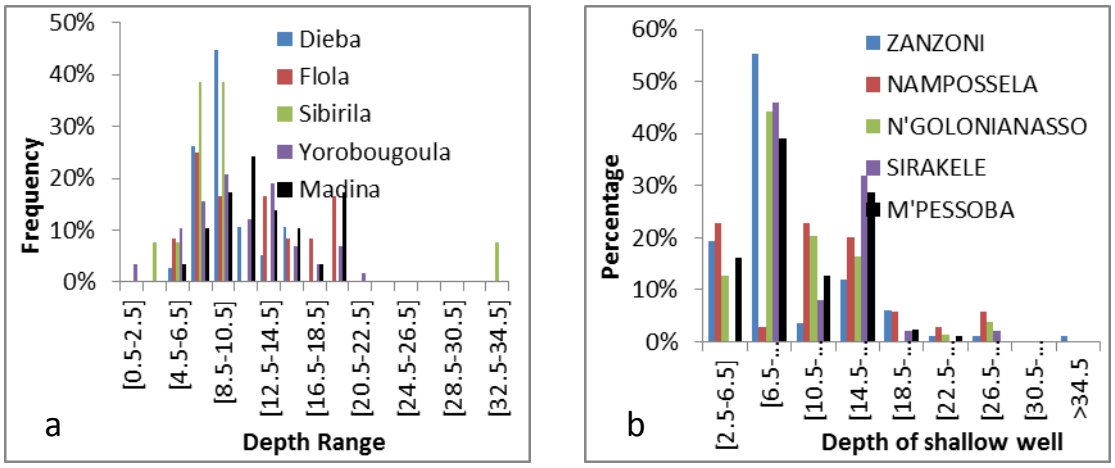


Figure 28: Depth of water in the shallow wells in Bougouni; (a) dry season, (b) rainy season

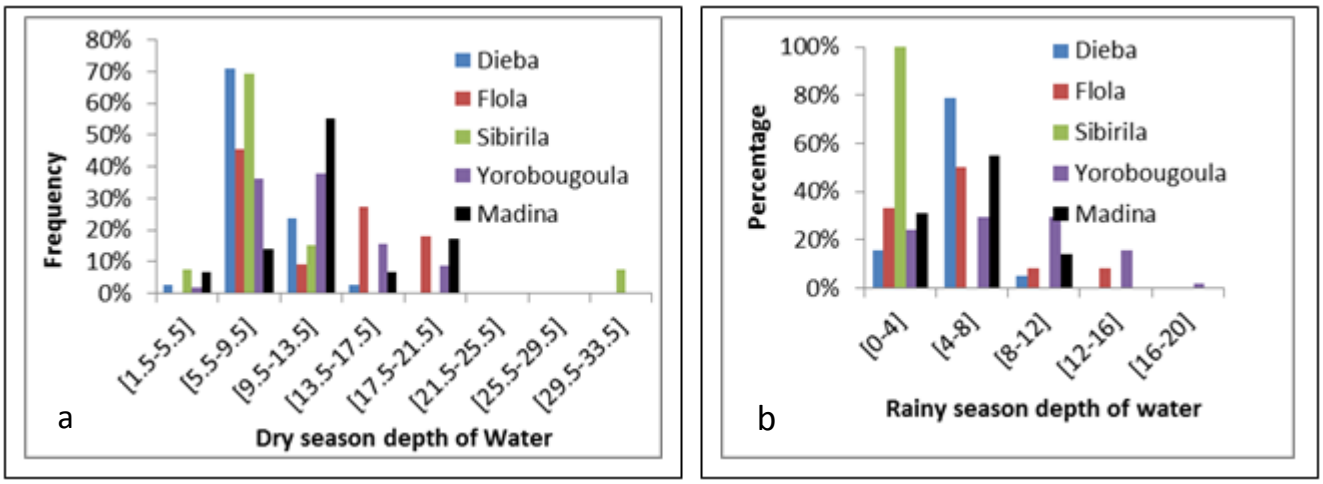


Figure 29: Depth of water in the shallow wells in Koutiala; (a) dry season, (b) rainy season

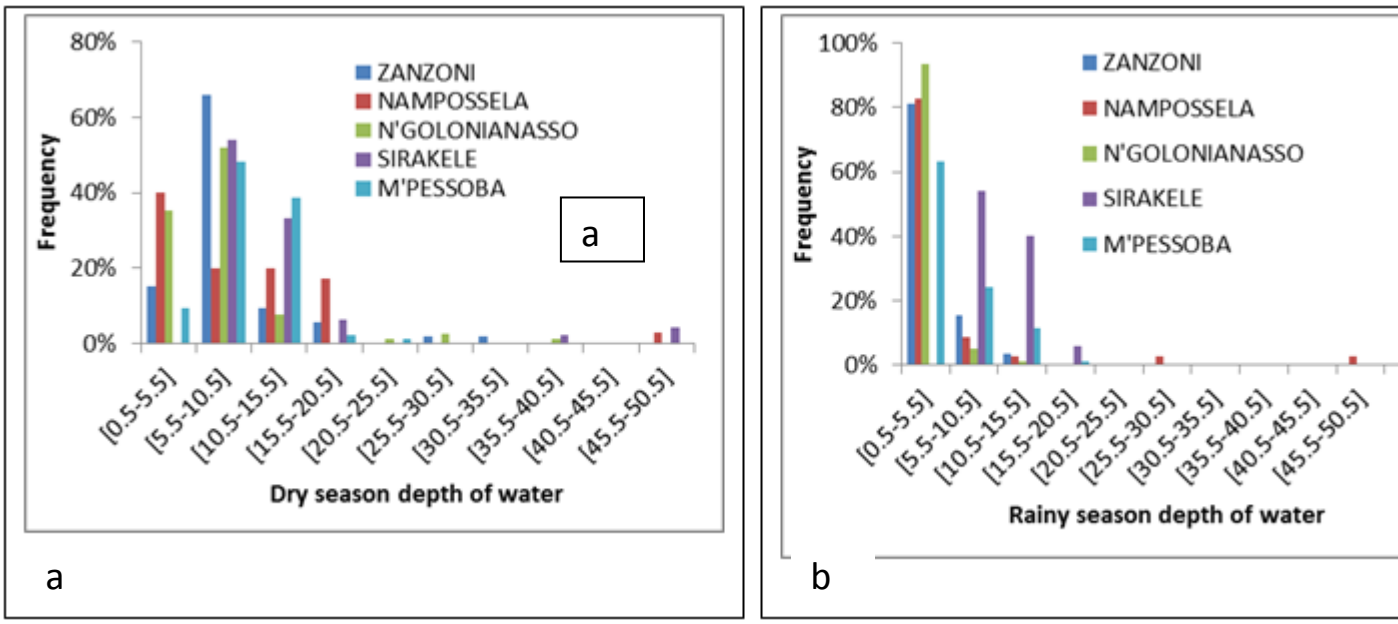


Figure 30: Mean grain yield of 5 cowpea varieties, tested in 4 fields in Sirakele under Farmer practice and Improved practice (with DAP application, higher stand density)

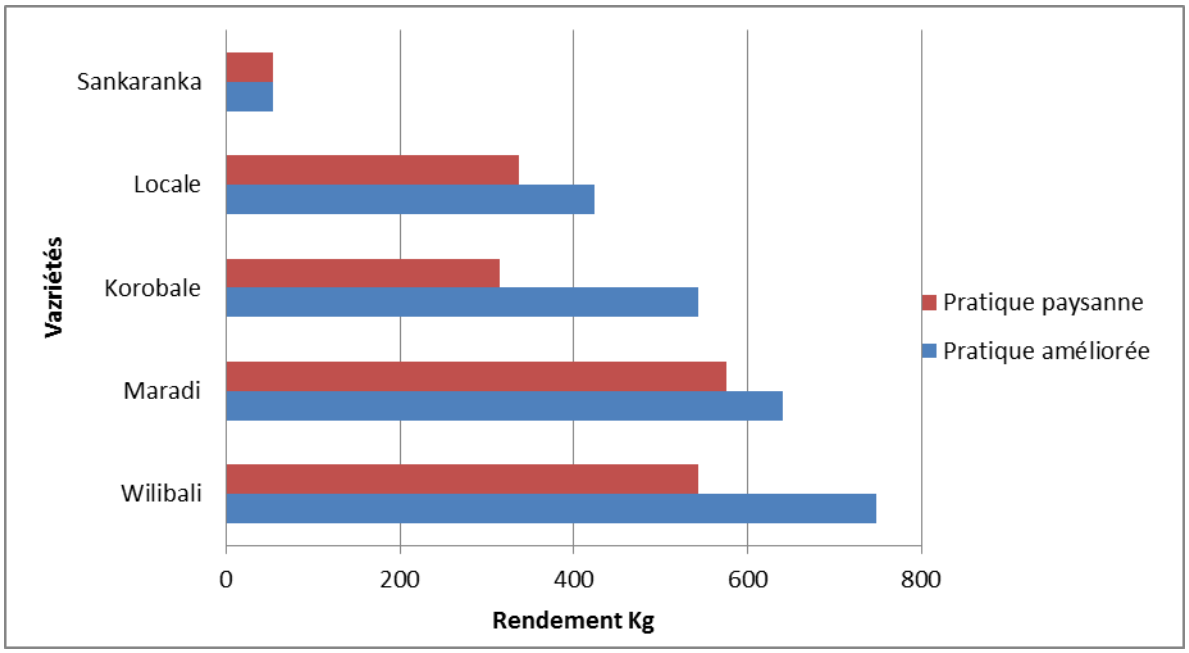


Figure 31: Results for the two test varieties

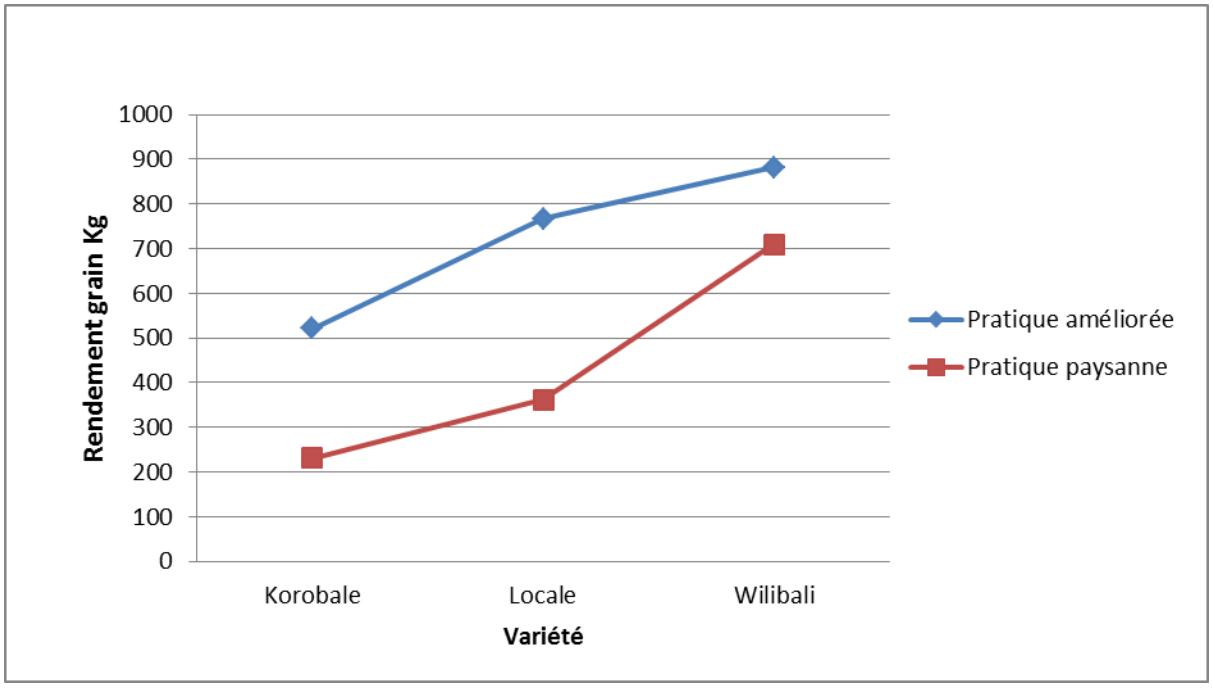
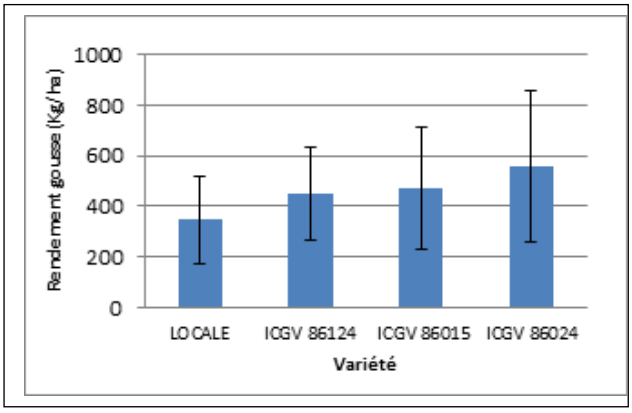
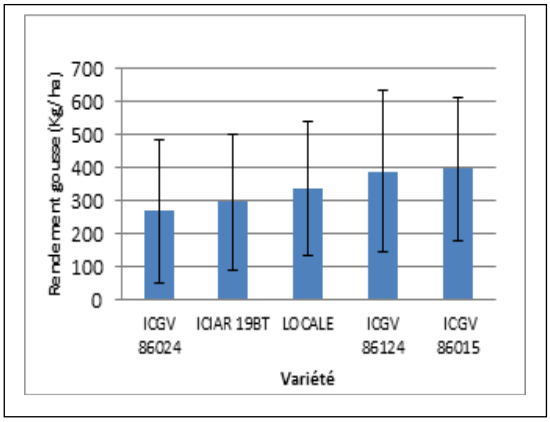


Figure 32: Average Yield result (kg/ha) for groundnut trial establishment in M'pessoba (a) and Sirakele(b)





Section E. Success story (for final report only, 200-300 words)

Here we present one of the many success story the project achieved during the reporting period.

The training workshop on conflict management over natural resource use in the Sudano-Sahelian Zone of Mali was held in Bougouni and Koutiala. The training workshop was a success story for the following reasons. (i) It provided occasion for coming together of different social groups, technical services, and officials of the local government authority to discuss the causes of conflict and the innovative approach to resolve the conflict. Sometimes the exchanges were hot between participants from the community members and the officials of the local government who were often perceived by the farmers as partisan in their intervention to resolve conflict. But at the end, the training provided opportunity to build trust between the community members and the local government officials and the technical services particularly the forestry officials. (ii) The training strengthened the capacity of the community leaders, the local administrative officials and technical services in diagnosis of causes of conflict, and the processes to follow in resolving it. (iii) The community leaders who participated at the training agreed to organize training for their community members. (iv) The course materials were provided to participants of the workshop to facilitate the training at the community level. Evaluation of the training by the participants showed that 72% were very satisfied with the content and techniques of the training and 28% were satisfied.